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THE DESIGN FOR A BASCULE BRIDGE, prepared by Mr. Thomas E. Brown, Jr., M. Am. Soc. C. E., of New York city, has been adopted for the crossing of Newtown Creek at Vernon Ave., Brooklyn, N. Y., by the joint bridge committee of the Brooklyn board of aldermen and the Queens County board of supervisors. The clear span is to be 150 ft., and the bridge will have two leaves 85 ft. long, with 75-ft. swing, operated by cables passing over sheaves in towers on the abutments, these cables being attached to three points in each leaf. The hoisting plant will be operated by hydraulic power. It was at first proposed to have a swinging leg under the free end of each leaf, to rest on a foundation in the bed of the creek when the bridge was closed, but this feature has been wisely abandoned. The bridge will have a 34-ft. roadway, two 6-ft. sidewalks, and will be 8 ft. above the water line. The estimated cost is $165,000, or $200,000 including the piers. Mr. John J. McLaughlin, M. Am. Soc. C. E., County Engineer of Queens County, is engineer for the bridge committee. Some of the other competitors have entered protests against the acceptance of the Brown designs, but the committee has decided to ignore them.

THE COLUMBIA BRIDGE, over the Susquehanna River, at Columbia, Pa., was swept away by the recent great wind storm. This bridge was about 1¼ miles long, and was claimed to be the longest covered bridge in the country. The first bridge at this point was completed in 1812, at a cost of $232,000, but the structure was carried away by an ice freshet in 1832. It was rebuilt at an expense of $157,300, and was burned in June, 1863, to prevent the passage of Confederate troops, who were then in the adjoining county to the south. The Pennsylvania R. R. Co. bought the old piers and, in 1869, built a wooden railway bridge across the river, with one iron span in mid-stream. This bridge was used for freight trains to Baltimore and other points. The iron span alone remains. The storm lifted the wooden spans clear from the piers, but left the latter uninjured.

THE NEW YORK & BROOKLYN RY. CO. has filed a certificate of incorporation for the purpose of building and operating a railway tunnel between the two cities, two miles long. The New York end would be near Broadway, somewhere between Canal St. and the Battery, and the Brooklyn end would be near Fulton St., "between the City Hall and the East River." The capital named is only $20,000, and the directors for the first year are Alonzo B. Cornell, B. S. Henning, Otto Andrae, Jr., Fritz Hill, J. D. Miller, Jr., P. C. Schnitzer, S. R. Haxtun, E. R. Hoadley and Irving Washburn. This is apparently a revival of the Henning gravity railway tunnel project.

THE IMPROVEMENT OF THE EAST RIVER FRONT of New York has been reported upon by the board of consulting engineers, made up of Mr. George S. Morison, Prof. William H. Burr, and Gen. William P. Craighill. This report supplements that of Feb. 6, 1896, on the North River front, given in abstract in this journal. In the former report provision was made for railways along the proposed marginal North River street and the board believes that the same should be done for the East River, and some radical changes are called for in this connection. A large part of the freight traffic of the New York, New Haven & Hartford R. R. naturally comes to this section of the city and it would seem better to reach this district by land than by water. A single large ferryhouse at the Battery would also better suit public convenience and occupy less space than the several existing houses. The board considers the transfer of the Sound steamboat business from the North to the East River as desirable, and as better accommodating the public by saving at least a half hour in time; but the transfer involves so many questions that it must be handled with a great deal of care. The full report divides the East River front into four sections and discusses each section with reference to docks, piers, etc.

THE DREDGING OF THE CHICAGO RIVER, ordered by the U. S. Government and to be commenced on Nov. 15, is likely to destroy abutting dock property if early precautions are not taken by the owners. The contract calls for the removal of 1,306,942 cu. yds of material and an increase of the depth of the river to 17 ft. Many docks and other structures on the banks are founded at a depth of 12 to 15 ft., and Capt. Marshall, Corps of Engineers, U. S. A., now warns property-owners that they cannot recover damages from the U. S. Government if their docks are undermined and slide into the river. On the contrary, if such accidents occur, the owners make themselves liable to penalties, under the law relating to the obstruction of navigable channels being improved by the government. After the government has finished its work, the Drainage Channels Trustees will increase the depth in places to 24 ft., thus adding to the danger to adjacent property.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a derailment caused by the explosion of the boiler of a locomotive Oct. 4, near Osage City, Kan., on the Atchison, Topeka & Santa Fe Ry. The engine was hauling a passenger train and should have stopped at Osage City for water, but being late it was run on towards the next water station. When about two miles beyond the city the boiler exploded, and as a result of the sudden check some of the forward cars were telescoped, and others were overturned, while all the cars were derailed. There were seven persons killed (including the engineman and fireman) and four or five injured.——A train of freight cars on the Quinnimont Coal & Iron Ry., near Quinnimont, W. Va., ran away on the steep grade Oct. 7 and left the track at a sharp curve. The engine and all the cars were wrecked; two men were killed and two others badly hurt.

A LOCOMOTIVE BOILER EXPLOSION occurred Oct. 7 at Meriden, Conn., on the New York, New Haven & Hartford R. R. The engine was hauling a northbound freight train at the time. Nobody was killed or badly hurt.

A BOILER EXPLOSION at the Montour Iron Works, Danville, Pa., on Oct. 8, killed six persons and seriously injured 30 more, some of them being fatally injured. The boiler was about to be put out of service to allow of repairs being made, and men were at work repairing the brick work of the furnace.

AN EXPLOSION IN A FOUNDRY CUPOLA occurred Oct. 8 in the works of the Singer Sewing Machine Co., at Elizabeth, N. J. The iron had just been tapped and run off and the furnace men were moving away when the side of the cupola was blown out. Two men were badly injured and burned.

AN EXPLOSION OF ACETYLENE GAS occurred Sept. 12 in a restaurant at Lyons, France, causing a great amount of damage to the building and the neighboring buildings, while five persons were injured. The fire underwriters submitted a report on the case to an expert, who gave the opinion that the acetylene system may be accepted if an additional premium is charged, and the apparatus installed outside the building or in an unoccupied and well ventilated place.

THE AMERICAN LINE STEAMSHIP "PARIS" was disabled, on Oct. 2, by the fracture of the starboard shaft in the tube next to the outboard shaft tube. The "Paris" was 320 miles east of Sandy Hook at the time of the accident bound to Southampton. She proceeded on her journey with one engine, at the reduced speed of about 15 knots per hour, after sending the news to New York by the "Fuerst Bismarck."

STREET CAR FENDERS OR WHEEL GUARDS which can be dropped by a catch operated by the moforman are to be tried at New Haven, Conn., the Railroad Commissioners having given permission for the use of these fenders instead of the present ones which are operated by an automatic trip released by any obstruction on the track.

THE BROOKLYN NAVY-YARD CAISSON ACCIDENT is practically disposed of by the announcement that the Secretary of the Navy will take no further action in the case. Experts called during the final sitting of the court of inquiry declared that the calculations of Mr. Menocal were entirely correct and that by these figures he was justified in removing the ballast. His friends also contend that other and unknown causes may have been at work, as no one knows what happened in the several hours intervening between the completed removal of the ballast and the accident. As the Secretary has expressed doubts as to Mr. Menocal's responsibility, it is understood that he is to have the benefit of this doubt.

AIR-POWER FROM COMPRESSED AIR is being supplied to all tenants of the Havemeyer Building, New York, who may desire it, by the Ingersoll-Sergeant Drill Co., which has its offices in the same building. A steam-driven compressor is located in the engine-room and the building is piped throughout, through the elevator shaft, with branches at the several floors. The Ingersoll Company will be the largest consumers in operating tools and machines of all kinds for exhibition; but this power is also used in their offices to open the doors, ring call bells, operate the letter presses, dust furniture and clean the carpets, rugs, etc.

AN ELECTRIC PLANT, to be operated by water power, is in course of construction at Tampa, Fla., by the Consumers' St. Ry. & Power Co. A wing dam has been constructed across the Hillsborough River, which is stated in a press report to be 22 ft. high with a 60-ft. base. The river flow is 50,000 cu. ft. per minute. The total horsepower of the plant is 1,400. A steam plant is also to be added for use when the steam is low.

THE BOSTON PNEUMATIC TRANSIT COMPANY'S permission from the Boston Aldermen to lay and operate underground pipes in that city has been vetoed by Mayor Quincy. The ground of objection is that the franchise is not accompanied by a contract protecting the interests of the city and securing some pecuniary returns to the city treasury. The grant from the Aldermen simply defined the route and stipulated that the company shall transport free all matter pertaining to the official business of the City of Boston which can be transmitted through its system.

LOW BIDS FOR CEDAR BLOCK PAVING were recently received at Port Huron, Mich., the contracts being awarded at 37 cts. per sq. yd. for cedar blocks upon a sand foundation. The detailed bids were published in our Construction News Supplement last week. Mr. F. F. Rogers is City Engineer.

THE PRESENT AND FUTURE WATER SUPPLY OF Brooklyn is discussed at some length in a special report by Mr. I. M. de Varona, M. Am. Soc. C. E., Engineer of Water Supply, made public Oct. 6. Mr. de Varona was requested to report on the cause of and remedies for the recent taste, odor and color in the Brooklyn water supply, the time when an additional supply, outside of sources now under development, would be needed, and the best means of securing such a supply. The report states that the cause and remedies cannot be stated with definiteness until the water has been more extensively studied, especially from a biological point of view. The general cause of the taste and odor is decaying organic matter, but whether this arises chiefly from growths in the surface or driven-well supplies cannot yet be said. An additional water supply, Mr. de Varona says, should be available in five years, which would require the immediate beginning of construction. Further investigations for a new supply must be made before selecting the source. Although strongly in favor of municipal control of all portions of a municipal water supply, Mr. de Varona believes that financial conditions may make desirable a contract with a private company for the development and delivery of more water, with ultimate private ownership.

AN EXHIBIT OF VALVES AND HYDRANTS and their accessories will be held on Nov. 10, by the Department of Public Works of New York city. Manufacturers of such supplies are requested to send illustrations and literature explanatory of the same to Gen. Chas. H. T. Collis, Commissioner of Public Works, 150 Nassau St. Only articles selected will be placed on exhibit. The exhibit will be held at the corporation yard. Exhibitors must bear all the expense of their respective exhibits and have a representative on hand to explain the same. The mayor, board of underwriters, engineers of city departments and the press will be invited to inspect the exhibit and "experienced judges will be appointed to examine and report upon the merits." The object of the exhibit is stated to be "to ascertain the state of the art relative to such contrivances with a view to improving the city service." All communications on this subject should be addressed to Gen. Collis, as above.

NOTES OF A TRANSCONTINENTAL TRIP.

III.

Denver & Rio Grande R. R.

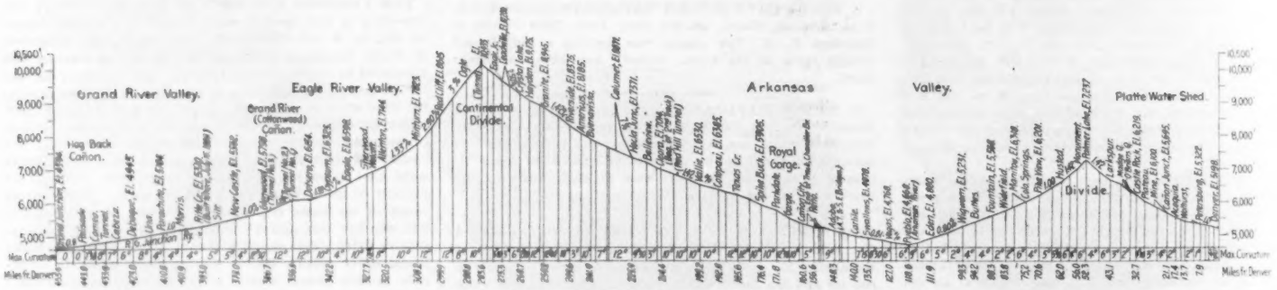
This noted railway was first projected and built at the time when the narrow gage fever was at its height among promoters and engineers, and a 3-ft. gage was adopted as promising a lower cost in construction and operation and a greater facility for the sharp curves of a mountain railway than could be obtained with the standard gage. The construction was commenced in 1871, and for a long time this railway was held up as an example of the benefits of a narrow gage line, especially for mountain railways, the old arguments about the lower cost, the greater facilities for sharp curves, the greater proportion of live load to dead load, etc., being worked pretty hard for some years. As the fallacies of these arguments became more fully recognized, and as the standard gage system extended, the Denver & Rio Grande R. R. became isolated, possessing no facilities for through traffic. This led to the adoption of the standard gage, and the change was commenced on the main line between Denver and Pueblo, in the summer of 1880, at which time the system had a total extent of 337 miles (all narrow gage), but it was not until 1890 that the standard gage track was completed through to Grand Junction, the western terminus (and the connection with the Rio Grande Western Ry.). The line has now 305 miles of standard gage main line from Denver to Grand Junction (via Pueblo and Leadville), and south from Pueblo to Trinidad; 296 miles of narrow gage main line, extending from Salida south to Santa Fe, N. M., and west to Grand Junction (via Gunnison); and 278 miles of mixed gage, from Denver to Pueblo and Leadville. This latter is maintained in order to provide for through trains over both lines and also for the through haul of ore from the narrow gage branches at the mines about Leadville to the smelters at Pueblo.

Some interesting notes on the rails used on this line, with illustrations of the various sections from the 30-lb. rail of 1871 to the 85-lb. rail of 1896, were given in Engineering News of Sept. 3. Reference was there made to the use of a combination of 85-lb. and 65 lb. rails on the mixed gage on three-rail track, so that one of the outer (85-lb.) rails carries wheels of standard gage rolling stock only, while the other carries the wheels of both standard and narrow gage rolling stock. In answer to an enquiry as to the relative wear of these rails, Mr. M. H. Rogers, Chief Engineer, stated that thus far very little difference has been observed in the wear of these rails. The narrow gage trains passing over this track are usually hauled by standard gage engines, so that no difference in wear on the two rails would be due to the engines, and the load on the wheels of the narrow gage freight cars is small in comparison with the load on the driving wheels of the engine. It is to be remarked, however, that the difference in height of the two rails forming the narrow gage track probably have some influence on the steadiness of running of the trains and on the wear of the wheels and trucks. On another page of this present issue is shown the track construction with 85-lb. rails, and also a turnout and crossover on the mixed gage track, where the three rails make a somewhat complicated arrangement. The stub switch is almost universal. Some of the new 85-lb. rails are being laid south of Colorado Springs, new ties are being put in (and they are badly needed in places), and a considerable amount of gravel is being put in to raise the track to grade and shoulder out the ballast.

There are some very fine locomotives on this line, but no very new narrow gage engines, as the extension of the standard gage system has given the road a surplus of these and none have therefore been built or bought for some time. Both diamond-top and straight smokestacks are used. The narrow gage freight engines were originally built with diamond stacks, and have never been altered, but the straight stack and extension smokebox are the present standard, and are applied on nearly all the standard gage engines, and narrow gage engines in passenger service. It was noted that the height of most of the straight stacks had been increased by putting on a piece extending about 12 ins. above the top molding of the original stack. On enquiry it was found that this has been done on account of the trouble experienced from smoke blowing into the cab when steam was shut off. The straight stacks are made as high as possible consistent with the limits imposed by bridges, tunnels, etc. The doors of some of the roundhouses, however (built for narrow gage engines), are unusually low, and the tops of the smokestacks are made movable so that they can be removed by the hostler when the engines are put into the roundhouse. Mr. Henry Schlacks is Superintendent of Machinery.

The main shops are at Burnham, just outside Denver, but there is not much work going on, with the exception of ordinary repairs and some new narrow gage car work. From the look of a number of driving and truck wheels waiting to have their tires re-turned, it would seem that a limit of tire wear is not very closely observed, but that engines are allowed to wear their tires pretty hollow before being sent to the shop. The responsibility for this may perhaps rest with the traffic department rather than with the mechanical department, as is the case on a good many roads.

Frogs (rigid) and switchstands are manufactured at these shops. The narrow gage sleeping cars and day cars are practically the same as those for the standard gage lines, except that they are somewhat smaller and have narrower berths and seats. The narrow gage sleeping cars were all built by the Pullman Palace Car Co.



PROFILE OF THE DENVER & RIO GRANDE R. R.

Denver to Salt Lake City (D. & R. G. R. R. and R. G. W. Ry.).

All narrow gage trains on the mixed gage portions of the Denver & Rio Grande R. R. are hauled by standard gage engines, the drawheads on the tenders having three sockets (side by side) for the coupling pin, so as to fit the coupling of standard and narrow gage cars. The narrow gage engines are also similarly fitted, so as to haul either narrow gage or standard gage cars. The New Mexico express (for Santa Fe, N. M.) by which I traveled from Denver to Colorado Springs on July 7, is a narrow gage train hauled by a standard gage engine, a shackle bar (like that on an engine pilot) connecting the drawhead on the car with that on the tender. Owing to this arrangement an extra length of brake hose was required between the tender and car, but as this sagged to the ground the brakeman gave it two turns around the shackle bar, so that a casual observer (even uninfluenced by Colorado whiskey) might not unreasonably have thought that he saw a snake crawling from the engine to the train.

The California Fast Mail, on which I left Colorado Springs, July 9, is a standard gage train with through cars to San Francisco. It has no dining car, but stops at Pueblo for lunch and at Leadville for dinner. At the former place there is a handsome station, with a very poor lunch room, the principal article of food available being the usual imitation chicken (apparently manufactured of leather and parchment specially for railway use). At Leadville the station does not amount to much, but there is a good and plentiful meal provided. The hurry and scramble, however, are very objectionable and trying, and while the patronage does not probably warrant running a dining car service it would seem as though a buffet car service might be afforded.

Pueblo, 120 miles from Denver, is an important railway center and a manufacturing city, having the large iron and steel works and rolling mills of the Colorado Fuel & Iron Co., flour mills, and extensive smelting and reduction works for the treatment of the ores brought from the mining districts. It is 4,667 ft. above sea level and has a population of 35,000. At Florence, the junction of the branch to Cripple Creek, are sidetracks crowded with cars loaded with machinery and supplies for, and ore from, the Cripple Creek gold mines. Oil and coal are found in this vicinity, the present output being given as 5,000 tons of coal and 2,000 barrels of oil per day, while natural gas is supplied for domestic use. The railway now approaches the mountains, following the course of the Arkansas River, and then enters the Grand Canyon of the Arkansas at the narrowest part of which (the Royal Gorge) the walls rise almost vertically for a height of, in some places, 2,600 ft. For eight miles the line runs along the bottom of this narrow and tortuous gorge, following every curve and bend of the river, and not far above the water, the roadbed being in many places a gallery cut in the face of the rock. In this gorge is the notable plate girder bridge over a tributary stream, the outer girder being suspended at the middle from an iron inverted V spanning the Arkansas and abutting in the rocky walls of the canyon. This bridge was described in the "Transactions of the American Society of Civil Engineers." The noise of the rushing water and the reverberating roar of the train are almost deafening. Salida (elevation 7,049 ft.) is the junction of the two main lines to Grand Junction (one standard gage and the other narrow gage), and the narrow gage line to New Mexico. At Granite (elevation 8,945 ft., 259 miles from Denver) are extensive placer mining workings.

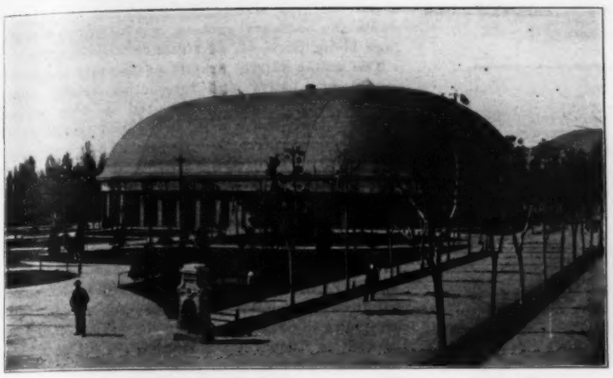
Just beyond Granite, while running along an embankment, the engine (a ten-wheeler) struck a boulder lying on the track, throwing it to one side so as to derail the front pair of truck wheels. Fortunately the truck did not slew very much out of line, and the train made an emergency stop in three or four car lengths, with the wheels not far from the rails. Wrecking wedges or frogs of hard wood were put behind the wheels, and the engine backed up until the wheels dropped into place on the rails. The delay did not exceed 10 or 15 minutes.

Leadville is reached by a long loop with heavy grades, and two engines are used for the ascent,

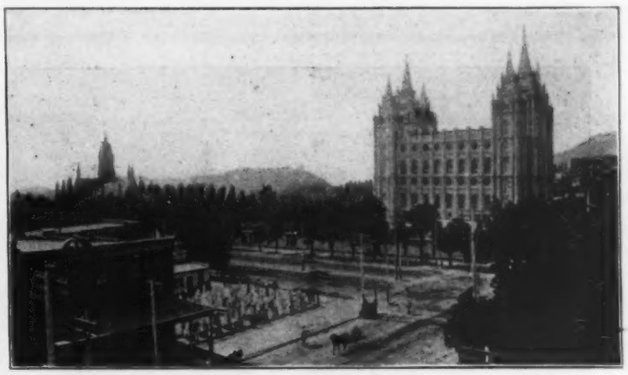
taking a run at the grade at high speed and going up in fine style. This city was the center of a great gold mining district from 1859 to about 1870, being then known as California Gulch. It then became partially abandoned, but the discovery of the carbonate silver ores in 1876 gave it a new start, under its present name, and it is now the center of a silver mining industry, its population being about 20,000. Its elevation is 10,200 ft. above sea level, but the highest point reached by the railway is the summit of the Tennesse Pass, 10,240 ft., where a tunnel effects the passage from the Atlantic to the Pacific slopes. The Grand River canyon and the 250 miles of the Colorado Desert were passed at night. At Grand Junction, 456 miles from Denver (elevation 4,594 ft.) the two lines of the D. & R. G. R. R. from Salida and the line of the Colorado Midland R. R. converge. This point is the western terminus of the Denver & Rio Grande R. R. proper, but the Rio Grande Western Ry., which extends from here to Salt Lake City and Ogden is practically an extension thereof, giving the D. & R. G. R. R. a connection with the Southern Pacific Ry. for through communication with the Pacific coast.

Soon after passing Grand Junction, the line crosses the 250 miles of the Colorado Desert, a rolling plain of fine sand which I first saw about 5.30 a. m. on July 10, when near Green River. The sand permeates everywhere in spite of double window sashes and closed ventilators and doors. From this plain rise rows and blocks and pillars of rock, with vertical sides and horizontal strata, their outlines (as cut by the sand and wind) resembling massive castles and long lines of fortifications. The main range of these hills, north of the railway, is said to be 2,000 ft. high, and there are seams of coal visible, while in the higher plateau, north of the cliffs which form the face of the hills, are deposits of asphalt, gilsonite, ozocerite, etc. The sand of the desert has enough loam in it to break into a thin crust or scale, cracked like the bottom of a dry pond, while the irregular surface is gullied and washed, showing the effects of the heavy rainstorms which sometimes occur. It is said, on good engineering and agricultural authority, that the land is richly fertile if watered (being specially adapted for fruit growing), and that sufficient water can be obtained from the Grand River, and other rivers in the neighborhood, to enable a large part of the desert to be reclaimed. In fact a considerable amount of reclamation has already been effected. An example of what may be done here by irrigation is afforded at the little town of Helper, where the train stopped for breakfast (July 10), and where the bright fresh green of the trees, bushes and lawns, and the spray from numerous lawn sprinklers, were most refreshing after the unbroken yellow and gray colors of the desert. Similar oases are to be seen at Price and other stations. In addition to this, there are great coal deposits underlying this district, and west of Helper there are coal mines and nearly 100 coke ovens.

Leaving the desert the railway begins to descend the Wasatch range to the Utah or Jordan valley by a long steep grade full of curves. The summit of the grade is 7,465 ft. above sea level. The brakes are kept on most of the time, and the brakemen are on the alert, standing in the vestibules ready to pull the emergency cord in case of necessity. The speed is about 35 to 40 miles an hour, checked at sharp curves, and, of course, a hot box developed. It was on a mail car, and the journal had a lead-lined bearing. A copious application of cold water enabled the repair men to change the brasses and repack the box in a very short time, the journal, of course, being popularly supposed to be able to take care of itself if heated to a high temperature, and then dosed with cold water. At Midway, on this steep grade, is a catch siding with switch set normally for the siding, so that a runaway train will be diverted from the main track and turned onto the sand. Above the switch tower is a "Stop" sign, and the train comes to a full stop here, the towerman not setting the switch for the main track until the train is at rest.



THE TABERNACLE, SALT LAKE CITY.



THE TEMPLE, SALT LAKE CITY.

In the valley there is more vegetation, with signs of the irrigating ditches, by means of which the sagebrush desert has been converted into orchards, farms, and gardens. The bottom of the valley, between the toes of the mountain slopes, is almost perfectly flat. Besides agriculture, there is the mining of rock salt, soda, gypsum and kaolin. Most of the towns here are practically Mormon towns. After seeing so much sandy desert and barrenness, the sight of the blue waters of Utah Lake is wonderfully refreshing to the eye and mind. This is a fresh water lake, about 10 × 30 miles, and from this the little Jordan River flows to the Great Salt Lake. At Provo is a woolen mill employing some 500 men, and at American Fork is what is said to be the largest beet-sugar factory in the country. The line passes the junctions of several branches to coal and gold mining districts (including that of the Salt Lake & Mercur Ry., described and illustrated in Engineering News, July 2, 1896), to the soda beds at Manti, to the rock salt deposits at Salina, and to the deposits of gypsum and potters' clay. The Mercur gold mining district is spoken of as a rival of the Cripple Creek district in point of importance, but I learned that considerable difficulty has been and is being experienced in satisfactorily extracting the precious metal from the ore. The cyanide process is used, with some modifications. After all these places the railway enters Salt Lake City, which I reached about 1 p. m. on July 10.

Salt Lake City.

It must be acknowledged that this city is somewhat disappointing in its first appearance, and hardly comes up to one's expectations. The streets are wide, but not in very good repair on the whole, and are very dusty. The irrigation ditches along the streets are either lined with cobblestones or overgrown with rank grass, and even the grass along these ditches is yellow, burnt and dusty in July. Nevertheless, the city is certainly imposing, and from a little distance one realizes that it actually is an oasis in the flat valley, few trees being seen outside of the irrigated limits.

The city is 4,228 ft. above sea level, and has a population of 50,000. It was laid out by the Mormons in 10-acre squares (660⅔ ft. square), with streets 132 ft. wide, every street having a stream of water flowing along each side (either in a ditch or in an ordinary gutter), and most of the streets having plenty of large trees. There are many modern office buildings, and the municipal and county offices are in a handsome structure known as the City and County Building, shown in the accompanying illustration. It is of Utah stone, from Kyune, and is 160 × 273 ft., 250 ft. high to the top of the dome. The two wonderful buildings here are the Tabernacle and the Temple, both situated in Temple Square, together with the Assembly Hall. The square covers ten acres, and is surrounded by a high stone wall. The Tabernacle is an oval building, 150 × 250 ft., with an elliptical domed or "turtle-back" roof, 100 ft. high at the center. This roof is composed of wooden arch trusses, as shown in Engineering News of Oct. 5, 1895, the top chord of which carries the outer covering or roof, which is of tin roofing, while the lower chord carries the smooth turtle-back ceiling, the trusses being entirely concealed. The building will seat 12,000 persons, but its acoustic properties are wonderful, owing largely to the peculiar form of the ceiling. The Temple is a fine stone structure, 100 × 200 ft., with three towers at each end. It was commenced in 1853, but was not completed and dedicated until 1893. Its cost aggregated nearly $5,000,000, and it is said to be the costliest ecclesiastical structure in the United States, with the single exception of St. Patrick's Cathedral in New York city. It is an imposing structure, but does not in reality appear so large as it appears in the accompanying picture, a remark which will apply equally to the Tabernacle. The general dimensions of the Temple are as follows:

Length	200 ft. 0 ins.
Width	100 ft. 0 ins.
Height:	
Central west tower ....204 ft.; with spire,	219 ft. 0 ins.
Central east tower .....210 ft.; " "	222 ft. 6 ins.
Side west towers .....182 ft.; " "	194 ft. 0 ins.
Side east towers .....188 ft.; " "	200 ft. 0 ins.
Height to top of main walls	167 ft. 6 ins.
Thickness of walls, bottom	9 ft. 0 ins.
" " top	6 ft. 0 ins.
" buttresses	7 ft. 0 ins.

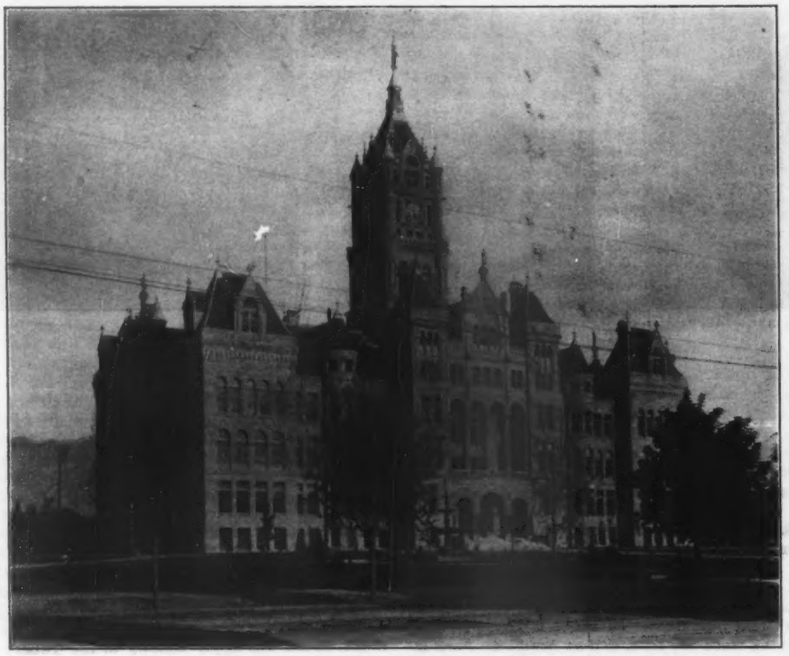
Business is dull now, and there is but little engineering work in progress. Several water power and electric power schemes are projected to utilize the water powers available in the mountain canyons, and two or three important ones are already in operation, notably those of the Pioneer Power Co. and the Big Cottonwood Power Co., noted in Engineering News, Oct. 1. It is not easy to see, however, that a sufficiently wide field is open for the application of the power when generated. On one hand it is stated that some of these projects are planned now so as to get control of the water rights, while the extremely low rates for machinery, supplies and labor are favorable to carrying on the work of construction. On the other hand it is argued that the promoters would hardly be likely to sink money in such plants without having some definite idea as to the application of the power to be generated. Irrigation works are somewhat numerous in this state, and one important enterprise—that of the Mount Nebo irrigation system—will shortly be described and illustrated in this journal. Mr. O. R. Young, the engineer for these works, has prepared a somewhat novel set of

earthwork tables, which give closely approximate quantities for slopes read off on the clinometer. They are thus specially advantageous for preliminary estimates, and it is believed that they are the only tables of the kind which have been prepared.

City Engineer's Department; Salt Lake City.

The office of City Engineer was only created on April 1, 1890, Mr. A. F. Doremus, M. Am. Soc. C. E., being appointed to that position for a term of two years, and then reappointed. On Feb. 13, 1894, Mr. Doremus was appointed chairman of the Board of Public Works, and Capt. Willard Young was appointed City Engineer. Mr. Doremus resigned his position on the board on Aug. 8, 1896. Mr. F. C. Kelsey was appointed Assistant City Engineer on April 5, 1890, and served in that position until March 11, 1896, when he was appointed City Engineer (to succeed Captain Young), which position he now holds. It is only within these past six years that there has been a systematic surveying and monumenting of the streets and lots, this work having been inaugurated by Mr. Doremus. The main part of the city has now been most carefully surveyed, and the surveys have been plotted in beautiful shape in record books, strongly bound in canvas boards. In carrying out this work, a standard of length was first established, and a very substantial system of monumenting was adopted. The street monument used is a stone post set in concrete, and having its top (with the center mark) covered with a cap to protect it and afford easy access. These and other details will be given in a separate article. The engineer department has large and attractive offices in the City and County Building, and on the wall is an immense blueprint map of the city, together with a set of blueprint block plans of the city, showing by colors and symbols the paving, water mains, sewers, electric lights, street railways, contract work, etc., and being exceedingly convenient for reference. Adjoining the office is a very large fireproof vault for the records, drawings, etc.; a large table is provided so that the books or drawings can be consulted and examined without taking them out of the office. All the original field books are kept here. There is also on one side of the vault a long set of large shallow drawers for tracings, etc., which are all systematically arranged, indexed and labeled. A wedge-shaped cleat is attached to each side of each drawer, and a square stick extending across the drawer is slipped under these, so as to hold the tracings down and keep them from curling or from shifting about. Records of paving work and contracts, with prices of work are kept in a special book, with the style of construction drawn on one page, and the records and statement of cost on the opposite page.

The system adopted for lettering plans is specially interesting. All ordinary notes, explanations, etc., are written by hand, the Reinhardt style of lettering being adopted, but for large titles, etc., Ockerson's hand stamps, with ordinary printing type, set in a frame are used. The largest stamp will print a title 6 ins. long at one impression. A plain open type of letter is used, and for the smaller sizes a type as near as possible to the Reinhardt style is adopted. A special ink is used, being a printing ink with plenty of dryer in it. Great care is taken in the proper placing and printing of the titles, and very good work is done, with much greater rapidity than might be expected, while the saving in time over the hand lettering of large titles is very considerable. One boy, at $30 per month, does all this and looks after the type, ink, stamps, etc., and the result is that the work is done quicker and better than by an ordinary draftsman at higher salary, besides insuring greater uniformity. This plan was adopted partly on account of its efficiency, and partly on account of the difficulty in getting draftsmen who could do rapid plain lettering in large sizes.



THE CITY AND COUNTY BUILDING, SALT LAKE CITY.

The city has a considerable amount of asphalt paving, but it is hardly recognizable at first, on account of the dusty condition of the streets, the care of the streets being under the charge of a political non-technical office. The pavement laid with asphaltic sandstone mined at Santa Cruz and San Luis Obispo, Cal., is the best asphalt paving in the city, and some of it which has been in use for five years has cost very little for repairs. Some portions of the pavement laid with Utah asphalt are in first-class condition, while others are badly cracked and show signs of disintegration. This would appear to indicate that the material makes a good pavement if properly manipulated. The Salt Lake Stradamantic Asphalt Co. paved one intersection to introduce its material, which it called stradamantic asphalt, but the pavement was a failure, and the company failed to repair it when requested to do so. The following statement shows the amount, kind and cost of asphalt pavement contracted for up to the present time; the contract prices include grading, except in the case of the last contract for 1896; this contract was awarded on Aug. 25, 1896, and the work is to be completed by Nov. 1:

Year Laid.	Area. Sq. yds.	Asphalt.	Thickness. Ins.	Concrete.* Ins.	Contract price. Per sq. yd.
1891	2,346	Cal. asphaltic sandstone...	2½	6	$2.74
1891	1,100	Stradamantic asphalt	2½	6	2.90
1892	14,989	Cal. asphaltic sandstone...	2½	6	3.24
1892	2,871	Utah asphaltic limestone..	2½	6	3.24
1893	23,886	Utah asphaltic limestone..	2½	6	2.90
1893	15,100	Cal. asphaltic sandstone...	2½	6	2.79
1896	3,900	Utah asphaltic sandstone..	2½	6	2.74

*Asphaltic cement concrete.

On several of the business streets, the gutters and sides of the street are paved with red sandstone, while asphalt is laid between the street-car tracks and from the outside of these tracks to the block paving. The street railway company paves its portion (along the tracks) by separate contracts from those for the rest of the street. In these business streets the irrigation water flows down the ordinary gutters, special covered crossings being provided at street intersections.

The water supply system of the city comprises some very heavy and interesting works, which will be described and illustrated in this journal shortly. One of the most important recent works is the sewage farm, for treating the sewage from the gravity outfall sewer described in Engineering News of Jan. 4, 1894. The sewage was first turned into the sewer and main ditch on July 11, 1896, on which date I had the pleasure of visiting the farm in company with Mr. Kelsey.

Railways.

There are several railways projected in the neighborhood of Salt Lake City, but most of them are short lines to mining districts. The most important of the projected lines is the Utah & California Ry., which is to give Salt Lake City direct communication with the coast towns of southern California, and thus avoid the present roundabout route over the Southern Pacific Ry. by way of Sacramento. The line will run south over the Frisco branch of the Union Pacific Ry. to Milford, 221 miles; will then follow about 125 miles of roadbed graded in 1890 by the Union Pacific Ry. (and which can be put in condition for about $500 per mile); and will then strike across the lower end of Nevada into California. The southern terminus is not yet definitely decided upon, but the line may make connection with the Atchison, Topeka & Santa Fe Ry. at Barstow, thus getting direct access to Los Angeles. The total distance from Salt Lake City to Los Angeles, by way of Barstow, will be about 803 miles, of which practically 488 miles are built. The distance by the present route is 1,225 miles. The line would open up a coal and iron ore district (magnetite and hematite ores), and pass through a district said to be rich in gold, silver and lead, giving a rail communication to the mining districts of Pioche, Bristol, De Lamar, etc. The maximum grade to the north is to be 79 ft. per mile, with the exception of short lengths of 106 ft. per mile, while going south the maximum grade will be 53 ft. The minimum curvature will be 8°, except for some 10° curves in getting over the edge of the Salt Lake basin. There will be very few bridges or trestles, and it is said that no very heavy work will be encountered, and that the line (including stations, water supply and shops) can be built for $14,000 per mile. Owing to present financial conditions the scheme is temporarily shelved, and all field parties have been called in, but representatives of the company have been in the east trying to negotiate for the necessary funds for carrying on the work. Mr. H. M. McCartney, of Salt Lake City, is the Chief Engineer. He is also Chief Engineer of the Salt Lake & Pacific Ry., which is intended to run southwest to the Dugway mountains, opening up a district rich in carbonate silver-lead ores and other minerals. It will cross the Sevier Desert, and will be mainly in desert country, with light and cheap construction, and maximum grades of 80 ft. per mile. All mining supplies and materials would be carried in, and water might also be hauled. Some of the mines already opened have been abandoned on account of the cost of teaming or the impracticability of teaming over a country where

there is no water supply. It is not thought that this desert (which is a southern part of the Great American Desert) will ever be made available for cultivation, as there is no river available for a water supply and wells cost too much, except for irrigating fruit. Two lines of 100 miles in length have been surveyed, but further work remains in abeyance awaiting the improvement of financial conditions. The Rio Grande Western Ry. is proposing to build a line north from Provo to Park City, and to extend its Salina branch southwest to Richfield, Elsinore and Sevier, about 35 miles. The new Salt Lake & Mercur Ry. was described in Engineering News July 2, 1896. The Great Salt Lake & Hot Springs Ry., which is a steam dummy line, 15 miles long, has just completed an extension from Farmington to a new pleasure resort at Lagoon. The Chief Engineer is Mr. E. A. Vail.

STREET RAILWAY EASEMENT CURVES.

By Charles A. Alden, Steelton, Pa.

With the higher speeds and larger cars, which the advent of the electric railway brought in street railway work, the necessity of some sort of easement curve for the short radii required in street work very early became evident. The question as to its form has generally been considered as if the paths followed by all parts of the car were necessarily somewhat similar to the alinement of the track. This has led many engineers to believe that a three-centred curve was sufficient for practical purposes, besides being somewhat easier to design and calculate.

This assumption as to the path of the car is only true as to the small portion of the car which lies between the two axles or the center pins of a double-truck car. The parts of the car outside of this area describe rather peculiar paths, as is shown on the figures accompanying this article.

Fig. 1 is a case which the writer has seen repeated many times in the last few years. The curve is primarily designed to enable cars to pass each other on a double-track curve, but is also supposed to act as an easement. It will be noticed that there are four changes in the direction of rotation of the point A and also four abrupt changes in the rate of rotation of the point B.

It should be understood that the radii given for the short arcs in these paths are only given in order to convey an idea of the sharpness of curvature at these points, as these arcs would not be exactly circular, although nearly so.

These changes of direction in the path of A will occur at any P. C. C. of a three-centred curve, if the first radius is sufficiently long to be of any use in preventing the jar of striking the P. C. of the curve. The sudden changes in the rate of rotation of the point B will be found to occur at every P. C. C. of a compound curve unless it is of the form of the railway spiral with chords of a length shorter than the wheelbase of the car.

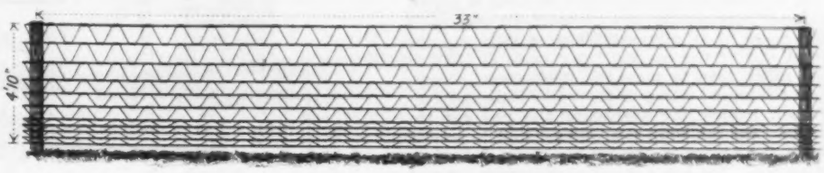
Fig. 2 shows exactly the same main curve shown in Fig. 1, but connected with the tangent by a spiral of seven chords having the following radii: 300, 150, 100, 75, 60, 50 and 40. The "spiral" is somewhat forced on the last radius in order to keep the center of the curve in exactly the same position while at the same time maintaining the same car clearance. The track curve does not vary in position at the center of the spiral more than 4 ins. from that shown in Fig. 1.

Note that there are but two changes in the direction of rotation of the point A. One of these is at the point where A leaves the tangent, from which there is a gradually decreasing curvature until it reaches the point of reverse curvature. From this point the curvature increases gradually until the point A attains its maximum rate of rotation parallel to the main curve. The rate of decrease and increase of curvature for both these arcs is somewhat less than that for the track curve. The point B also describes a curve with gradually increasing curvature until it reaches its maximum rate of rotation and follows the same path as A. The rate of increase of curvature would be somewhat greater than that of the track curve.

The car shown in these figures is by no means an extremely long car, as there are other cars known to the writer which are 30 ft. long, and others proposed which will be 38 ft. long and with only 6 ft. 6 in. wheelbase. The overhang of a double-truck car is nearly always as much as that shown in the figures. The sudden changes of motion shown in Fig. 1 exert a severe racking strain on the car framing which is particularly destructive to open cars as the connection between roof and floor framing is necessarily weak. The effect on the passengers is not pleasant, although this does not appeal so directly to the treasury of the railway.

The plan shown in Fig. 2 would cost for material just $12 more than Fig. 1, and would cost that much only for the most expensive track in use for surface roads.

The trouble involved in designing curves with spirals is very slight after adopting three or four spirals as standard suitable to the speeds of cars at the points in question. In fact, with proper formula, there is exactly the same number of operations required to solve for all the quantities that the constructing engineer needs, as there is to solve for similar quantities for a three-centred curve.



THE McMULLEN WIRE FENCE.

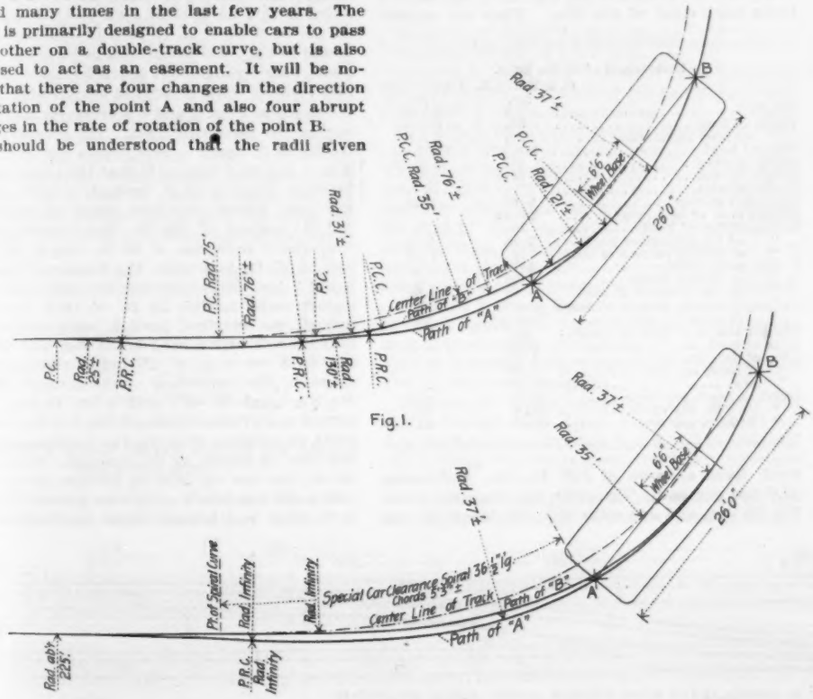


Fig. 1.

Fig. 2.

FIG. 1.—PATHS TRAVERSED BY POINTS AT ENDS OF A LONG ELECTRIC CAR IN PASSING ROUND A THREE-CENTERED CURVE.

FIG. 2.—PATHS TRAVERSED BY POINTS AT ENDS OF A LONG ELECTRIC CAR IN PASSING ROUND A CURVE HAVING SPIRALS AT ITS ENDS.

THE McMULLEN RAILWAY FENCE.

The growing favor with which wire fencing is being regarded by railway companies has resulted in bringing out a number of new designs of such fencing, and one of these (which was exhibited at the recent convention of the Roadmaster's Association of America) is shown herewith. The panel length, or distance between posts, is 33 ft. There are eleven horizontal wire cables, the top one composed of four No. 12 wires and the others of two No. 12 wires each. There are four lower spaces of 3¼ ins., then three of 6 ins., and three of 9 ins. The intermediate or binding wires are of No. 14 gage. This fence is manufactured by the McMullen Woven Wire Fence Co., 114 North Market St., Chicago, Ill., which also manufactures ordinary open mesh or woven wire fencing for railway and other purposes.

THE ROWAN STEAM STREET CAR MOTORS IN FRANCE

The combination steam motor cars of the Rowan system were first tried by the Paris Omnibus Co., during the Paris exhibition of 1889, four cars being used, and having a run of 1.55 miles in 10 minutes. At times each motor hauled a double-deck car seating 63 persons. After the exhibition the operation of this line ceased, but in October, 1890, the cars were put in service on the Pigalle-Trocadero line, for six months, and since September, 1891, they have been in service on the Auteuil-Boulogne line. The run of 1.86 miles is made in 12 to 15 minutes, including stops, and the three motors makes 122 trips per day, hauling a trail car on 38 trips. The motors are turned by switching on a Y at each terminus. The track is of standard gage. The following particulars are taken from an article in the "Revue Generale des Chemins de Fer."

There are six engines in operation, the two latest of which differ from the others in having double boilers. The car has an iron frame, the front end of which is carried by a four-wheel driving truck upon which is mounted the boiler (the engine and truck being detachable from the car), while the rear end is carried by a pony truck. The body of the car seats 22 persons, while 21 persons (paying a reduced fare) can stand on the two platforms, one of which is be-

tween the main body of the car and the engineman's compartment. The car is 30 ft. 6 ins. long, 6.56 ft. wide and 6.75 ft. high in the body. The distance from rear axle to center of truck is 18.6 ft. The engine consists of a vertical boiler (or two vertical boilers) mounted on a four-wheel driving truck, upon which rests the front end of the car, as already noted. The wheels are 25 ins. diameter, with a wheelbase of 5 ft. The frames are inside the wheels. The connection between the motor and car is effected by two vertical rollers at the back of the motor frame, between which slides a curved guide attached to the car frame. Side bearings are also provided, running in curved channel irons on the motor frame. To disconnect the motor it is only necessary to jack up the front end of the car until the guide is clear of the roller, then to raise the smokestack, disconnect the pipes leading to the water tank and condenser, remove the dashboard and run out the motor. The car body can thus be kept in service while the boilers or engines are being cleaned or inspected. The boiler is cylindrical, with rows of inclined water tubes passing through the upper part of the square firebox. The upper and lower parts of the shell are bolted together by outside flanges, so that they can be entirely separated for examination, which is done every six months. There are 131 tubes, 1.52 ins. diameter, with upset threaded ends screwed into the plates. The length between plates is 22.6 ins. The heating surface of the tubes is 95.01 sq. ft., and that of the firebox 17.43 sq. ft.; giving a total of 112.44 sq. ft., so that the evaporation is very rapid. The firebox is charged by means of small buckets instead of a shovel, each containing from 8 to 10 lbs. of coal. Three or four bucketsfull are thrown in, and this usually suffices for a round trip, but six extra buckets are carried for use on the road if necessary. The condenser is carried on the roof of the car. The weight of the motor is 121,000 lbs.

The cylinders are horizontal, 6.6 × 13.6 ins., and drive the rear axle, which is cranked, the leading wheels being driven by coupling rods. The Winterthur valve gear is used, which resembles the Walschaert's gear. In the newer engines, the boiler has two vertical shells and fireboxes, connected by a horizontal shell of the same diameter. The rows of tubes diminish in diameter and pitch towards the top. The cylinders are inside, and slightly inclined. The valve gear is of the Stephenson link type.

The motors are fitted with brakes, operated by a treadle lever, which lever is also connected with a Lemoine brake, having belts to drums on the axle and shoes to the driving wheel tires. Trail cars have the brake mechanism coupled up to that of the motor car.

STANDARD TRACK AND THREE-RAIL SWITCH WORK; DENVER & RIO GRANDE R. R.

The Denver & Rio Grande R. R. began life as a narrow gage line laid with 30-lb. rails, but, as shown by the comparative sections of rails on this road, in our issue of Sept. 3, the weight of rail has steadily increased until now quite a considerable portion of the standard gage main line is laid with 85-lb. rails. This present standard type of track we illustrate herewith in Fig. 1, from blue prints furnished by Mr. M. H. Rogers, Chief Engineer.

The rail is chefly noticeable for the roundness of its head, the top radius being 10 ins., with corners of 7-16-in. radius. The dimensions of this rail and the 85-lb. rail of the Am. Soc. C. E. section are given in the following table, and the weight of the steel of the D. & R. G. R. R. rail is taken at 10.204 lbs. for a section of 1 sq. in. one yard long:

The joint is of the supported type, with four-flanged Servis tie-plates on the joint and shoulder ties, these ties being 6 ins. apart in the clear. The the shoulder-ties are 5 × 8¼ ins. The rails are double spiked on the outside on each of these ties, the spikes being of the standard size, 5½ ins. long and 9-16-in. square. The angle bars are 24 ins. long, of heavy section in the web, the flanges being kept clear of the ties. They are of soft steel, have an area of 3.66 sq. ins., and weigh 47.6 lbs. per pair. The outer bar has oval holes, 1 × 1⅜ ins., and one spike slot; the inner bar has circular holes 1 in. diameter, and twe spike slots, plates on the joint-tie are 5 × 8¾ ins.; those on the bolt holes in the rails being 1⅛ ins. diameter. The spike slots are ⅝ × 25-32 ins., with corners of ⅛-in. radius. Button-head bolts are used, ⅞-in. diameter, with oval necks 1¼ × ⅞ ins., and having nuts 1 7-16 ins. square and ⅞-in. thick. The nuts are put on the inside or gage side of the rail, with Verona nutlocks between the nut and angle bar. The bolts are 6 ins. c. to c. In laying track the expansion spacing at the joints is regulated as follows, according to the temperature:

102° F.....	1-16-in.	24° F.....	¼-in.
76° F.....	⅛-in.	— 2° F.....	5-16-in.
50° F. (normal)	3-16-in.	—28° F.....	⅜-in.

This road is notable for having a considerable mileage of three-rail track, extending from Denver to Pueblo and Leadville, so as to accommodate the passenger trains of standard gage and the trains of narrow gage cars of ore from the mining branches to the smelters at Pueblo. Some notes of this track have been given in the article on the D. & R. G. R. R. rails in our issue of Sept. 3, and in the transcontinental notes in our present issue. This arrangement of tracks makes the switch and turnout work somewhat complicated, and we illustrate in Figs. 2 and 3 a crossover and a turnout on the three-rail track. The crossover is for tracks 13 ft. apart c. to c., while for tracks 12 ft. c. to c. the only change is that the center distance between frogs is 22 ft. instead of 30 ft., making the total length over heel joints of switch rails 182 ft. instead of 190 ft. The turnout requires four guard rails, one of 45 ft., two of 26 ft. and one of 15 ft. in length, the flangeway for these being 2 ins. Stub switches are used, with 30 ft. switch rails, having 24 ft. of their length unspiked, the unspiked portion being connected by four tie rods and a head bridle rod, and conforming to a curve of 8° 26' when thrown for the turnout. The main frog of the turnout shown is No. 8½ (angle 6° 44'), with a No. 10 frog for the narrow gage turnout rail and No. 1 or No. 2 double-point or crossing frog for the narrow gage main line rail, as shown by the diagram. There are 14 sawed ties for the moving portion of the switch rails; the headblock is of two pieces, 15 ft. and 4 ft. long, and beyond these headblocks are 40 timbers or ties. All the timbers are 7 × 9 ins., except the first two (headblock timbers) which are 9 × 12 ins.; the timbers aggregate 464 lin. ft., and 2,507 ft. B. M. The bill of timber is as follows:

1 piece	15 ft. 0 ins.	long.		3 pieces	11 ft. 6 ins.
1 "	4 " 0 "	"		2 "	12 " 0 "
4 pieces	8 " 6 "	"		3 "	12 " 6 "
5 "	9 " 0 "	"		3 "	13 " 0 "
3 "	9 " 6 "	"		3 "	13 " 6 "
3 "	10 " 0 "	"		3 "	14 " 0 "
4 "	10 " 6 "	"		3 "	14 " 6 "
3 "	11 " 0 "	"			

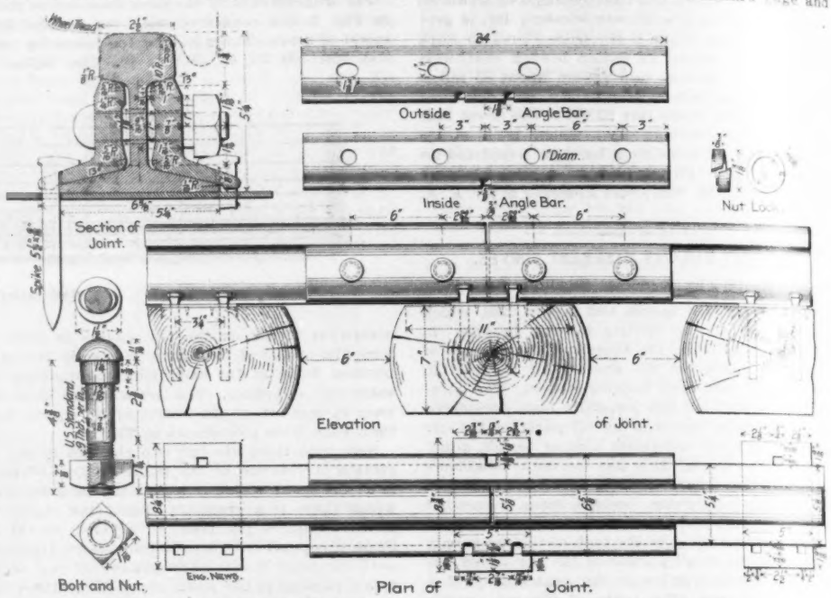


FIG. 1.—STANDARD TRACK WITH 85-LB. RAILS; DENVER & RIO GRANDE R. R.

Dimensions of 85-lb. Rails.

	D. & R.G.R.R. ins.	Am.Soc.C.E. ins.
Height	5¼	5 3-16
Width of base	5¼	5 3-16
" of head (maximum)	2½	2 9-16
Sides of head	Inc. 4°	Vertical.
Depth of head	1¾	1 35-64
Height of web	2⅝	2¾
Depth of base	¾	57-64
Thickness of web	9-16	9-16
Height to c. of bolt hole	2 3-16	.....
Radius of top of head	10	12
" of top corners of head	7-16	5-16
" of bottom corners of head.	⅛	1-16
" of top fillets	5-16	¼
" of bottom fillets	5-16	¼
" of top corners of base	1-16	1-16
" of bottom corners of base.	Sharp.	1-16
" of sides of web	Vertical.	12
Fishing angles of head and base	13°	13°
Area of head, sq. ins.	3.814	...
" of web, sq. ins.	1.506	...
" of base, sq. ins.	3.029	...
" total	8.349	...
Metal in head, per cent.	45.68	42
" in web, per cent.	18.04	21
" in base, per cent.	36.28	37

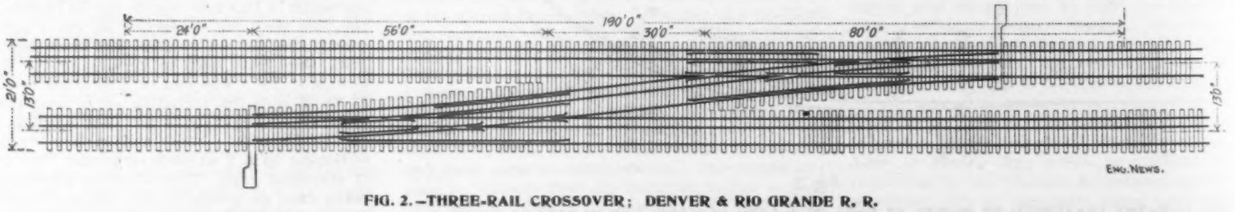


FIG. 2.—THREE-RAIL CROSSOVER; DENVER & RIO GRANDE R. R.

PROGRESS IN THE EQUIPMENT OF CARS WITH AIR BRAKES AND AUTOMATIC COUPLERS.

In our review last week of the statistical report of the Interstate Commerce Commission, just issued, we gave particulars of the progress thus far made in the equipment of railway rolling stock with air brakes and automatic couplers. In addition to those figures we present a summary, abstracted from the report of the number of couplers of each special make in use, as reported to the Commission. The figures represent the total number of cars and locomotives of all classes, equipped with automatic couplers as reported to the Commission. The summary is as follows:

Kind of coupler.	Total cars equipped on June 30, 1895.	Kind of coupler.	Total cars equipped on June 30, 1895.
Janney	143,726	Standard	5,947
Gould	105,725	Thurmond	5,529
Chicago	22,964	Dowling	4,908
Trojan	17,646	Tower	2,873
M. C. B.	17,591	Pooley	2,505
Miller	17,123	Williams	2,251
Buckeye	14,938	American	2,035
Safford	8,642	California	1,980
Van Dorston	7,703	Mather	1,570
Smillie	7,606	Drexel	1,039
Hinson	6,636	Blocker	1,385
Missouri Pacific	1,036		

It is to be remembered that the Interstate Commerce Commission's statistics are made up from the reports furnished by railway companies, and on matters of this sort, of course, contain more or less errors. Thus the "M. C. B." couplers should be credited to the different makers, in some unknown percentage. The Miller couplers are, of course, all on passenger coaches. The automatic couplers of the link-and-pin type, which cut quite a figure in the Commission's statistics a few years ago, have, most of them, disappeared, but the Safford and Blocker couplers in the above list are of this type, and, of course, should not properly be reported.

In train brakes the "odd" brake equipment cuts a small figure. The totals given are as follows:

Kind.	Total equipment fit'd. June 30, '95.	Kind.	Total equipment fit'd. June 30, '95.
Westinghouse	345,836	Lansberg	601
New York	12,391	Haberkorn	27
Boyden	1,491	Unclassified	45

AN AUTOMATIC BLOCK SIGNAL SYSTEM FOR SINGLE TRACK RAILWAYS.

At the recent convention of the American Society of Railroad Superintendents a system of block signaling for single track lines, with automatic electric disk signals and overlapping blocks, was described by Mr. J. Schreuder, Chief Engineer of the Union Switch & Signal Co., and this system we illustrate herewith. The diagram plan represents a length of double and single track equipped with the signals, which are of the disk or banjo pattern, while the points of insulation are also marked.

A train moving from A to O, the track being unoccupied and all switches propertly set, will find all signals clear. Signal No. 4, controlling movements from right to left, however, will be red, as it is, in part, controlled by the position of the switch Z, and will always show red while the switch is set for left to right movements.

The movement of a train from A to O, and the operation of the signals and indicators, will be as follows:

Entering A, the switch indicator Y is set to danger, thus giving warning at the crossover of the approach of a train. On entering B, indicator Y is still held red, while signal No. 1 is set to danger, thus protecting the rear of the train.

Leaving B, indicator Y is cleared, and on entering C indicator Z(2) shows red. This indicator is only operative when switch Z is set for left to right running.

Entering D, signal No. 3 is set to danger; as long as this section is occupied signal No. 1 remains red.

Entering H, signal No. 1 and indicator Z(2) are cleared, while indicator Z(1) is set to danger.

Entering I, signals No. 5 and No. 6 are set at danger. There is now no change until the train enters section K, when signal No. 3 and indicator Z(1) are cleared.

Entering L, signals No. 7 and No. 8 are set at danger.

Entering M, signal No. 6 is cleared.

Entering N, signal No. 5 is cleared.

Entering O, signal No. 7 remains at danger, while No. 8 is cleared. On leaving section O everything is returned to the normal position.

Now take a train running from right to left, with the switch Z set for the upper track, and signal No. 3 standing normally at danger. As the train enters section O it sets signal No. 7 at danger, and similarly sets signals No. 8 at N, No. 7 at M, and No. 6 at L. On entering section K, signals No. 7 and No. 8 are cleared, and at J the indicator Z(1) announces the approach of the train, signal No. 3 being already set to danger by position of switch Z.

Entering I, it sets signal No. 4 to danger, and at H clears signals No. 5 and No. 8, and continues to hold indicator Z(1) at danger.

At G, indicator Z(1) is cleared and indicators X and W are set to danger.

Entering F, it sets signal No. 2 to danger and still holds signal No. 4 red, while at E, signal No. 4 is cleared, but indicators X and W are still held red. Leaving E it clears signal No. 2 and indicators W and X.

A car on the fouling point of siding would set signal No. 2 and indicators W and X at danger; the siding switch being reversed the same danger signals would be displayed.

In setting the crossover, indicators W, X and Y and signal No. 1 would protect the movement.

A train moving from the siding to main line, single track, by way of switch Z, is protected by signals No. 4 and No. 1, set to danger by movement of switches, until it reaches C, where it sets indicator Z(2) to danger, and at D signal No. 3 is set to danger. When switches are set to their normal position all indicators are cleared except Z(2), and signals then protect the running as described in first movement.

In section K will be noticed a break in the rail. In practice the trainmen would be notified of such an occurrence by signals No. 6 and No. 5 being set to danger.

The function of the electric switch indicators, W, Y, X, Z(2) and Z(1), is to show trainmen working at a switch the condition of the track in both directions from the switch. That is, should a train be within the block in which the switch is located, the indicator will show red, thus giving notice that it would be unsafe to open switch. At each switch is placed a circuit shifting device, called a switchbox, which acts to set the signal to danger when switch is opened.

The following movements will show the protection afforded two trains traveling on the same track from opposite directions:

Train No. 1, on D, holds signals No. 3 and No. 1 at danger in rear, and signal No. 4 and indicator Z(2) ahead. Train No. 2 approaching from O, on reaching N will have signal No. 8 at danger in its rear and signals No. 7 and No. 5 in front. As train No. 1 is still in D, train No. 2 can proceed, and, on entering L will add signal No. 6 in its protection. Train No. 1 in entering H, clears signal No. 1 in rear, sets indicator Z(2) clear and Z(1) to danger, but as train No. 2, in L, is holding signal No. 5 at danger, train No. 1 is held by signal No. 5, and train No. 2 proceeds to signal No. 4 with the rear protection of signal No. 6. It will thus be seen that two trains cannot get together nearer than the distance of the overlap or the distance between two opposing signals on a single track.

This system is in use at the Pittsburg yard of the Allegheny Valley R. R.

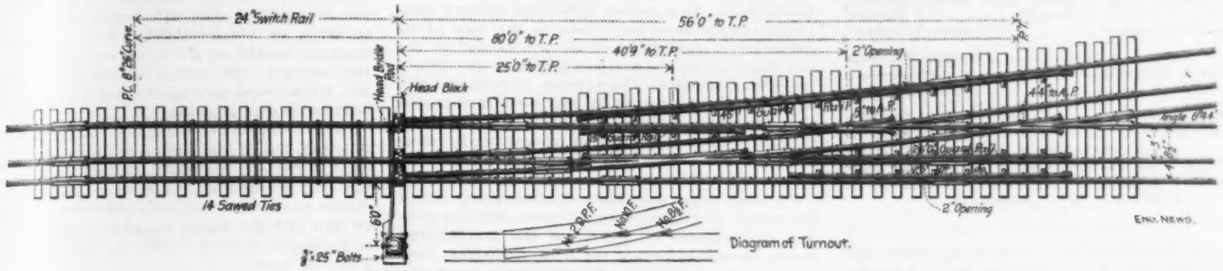
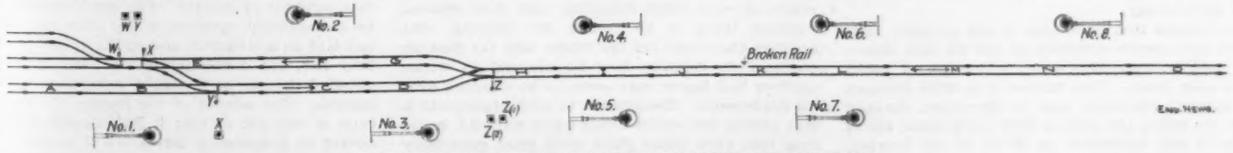


FIG. 3.—THREE-RAIL TURNOUT; DENVER & RIO GRANDE R. R.

DAMAGES FOR STREAM POLLUTION have been awarded against the Village of Saratoga Springs, N. Y., in one of the lower courts. The suit in question was one of several arising from the discharge of sewage in Kayaderosseras Creek. The decision holds that the sewage has rendered the stream flowing past the plaintiff's premises unfit for domestic use, that it has been rejected by domestic animals, and that it has caused the pollution of the atmosphere to such an extent during the warm months as to "seriously interfere with plaintiff's enjoyment of his right to live upon and occupy the said premises." Damages were ordered at the rate of $75 a year for six years or more, and it is averred that the plaintiff is entitled to an injunction to prevent the further pollution of the stream. The injunction is withheld for a year, but the plaintff may apply to the court for continuing damages.



AUTOMATIC BLOCK SIGNAL SYSTEM WITH OVERLAPPING BLOCKS.
Union Switch & Signal Co.

THE U. S. PATENT OFFICE, in the year ending June 30, 1896, received 45,645 applications for patents, reissues, designs, trademarks, etc. This is the largest number ever filed in any one year by nearly 2,000. The total receipts of the office for the fiscal year named were $1,307,090; and the total of receipts over expenditures now deposited in the U. S. Treasury to the credit of the Patent Office is $4,776,479.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

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ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes to standing advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

The preservation of cross ties, and the question of the relative first cost and ultimate economy of treated and untreated ties, is a subject which comes up periodically for discussion. It seems, now, to be pretty evident that while engineers very generally recognize the practical and financial advantages of treated ties, the managers and executive officers of railways are, as a rule, able to realize only the extra first cost of the tie, and do not yet sufficiently appreciate the economies due to increased life of ties and the saving of labor in tie renewals, so that the engineers have a campaign of education to conduct before they can expect to bring about the general use of treated ties. From a detailed estimate prepared by a railway manager some months ago of the relative cost of southern pine ties the following summary is taken: For untreated ties, heart-pine or pitch-pine is usually specified, and as this is valuable for sawmill purposes, it is only the logs which are defective for such purposes which are available for ties. Thus ties of this wood cost about 55 to 70 cts. each, delivered at New York, and have a life of about 7 years in northern or 5 years in southern climates. The life is limited by rail wear and checking as well as by decay.

For treated ties, pitch pine is not suitable, as it would not absorb sufficient of the oil, and short-leaf pine is, therefore, used, which has a much more open grain. This timber is in little demand for sawmill purposes, and is, therefore, cheaper than the other, the cost at New York being about 48 to 54 cts. untreated, or 85 to 94 cts. treated, while the life is about 12 years.

Let us now take the average of these figures and see what is the actual cost per annum of each tie.

	Untreated tie.	Treated tie.
Average first cost, cts.	51	90
Average life, years	6	12
Annual interest charge on first cost (4%), cts.	2	3.6
Annual outlay for a sinking fund which will replace tie at end of its life (interest at 4%), cts.	7.7	5.6
Total cost per tie per annum, cts.	9.7	9.5

It will be seen from the above that the actual annual cost of the two ties, on a road which can borrow money at 4%, is practically the same. With interest at 6% the treated tie would be more expensive than the other by 0.36 cts. per annum.

On roads where the above conditions prevail, therefore, the economy in the use of treated ties will arise in the economy of labor expended in track maintenance, rather than in the cost of the ties themselves. But on roads located in warm climates, where ordinary ties have a short life, or those located in regions so remote from a timber supply that ordinary ties are very expensive, there may also be a saving in the cost of the ties themselves. As a matter of fact the railway companies which have done most in the way of tie preservation are those which are located in the far South or on the treeless plains of the West. In view of the labor and expense of replacing ties in street railway tracks, it may well be expected that the street railway companies will soon find it to their advantage to adopt treated ties for their lines.

For some years past State Engineers and others interested in irrigation engineering and the general development of several of the far-Western states have been urging the U. S. Geological Survey to permanently mark upon the ground the elevations obtained in connection with its surveys. It was pointed out that without such permanent record of easy reference, much of the work performed by the survey was valueless, except for mere map-making purposes; and as the monuments used were of a very temporary character, all local traces of the survey were soon obliterated, and it was practically impossible to identify upon the ground the points and elevations marked upon the finely engraved maps which the Survey publishes. Prominent among the advocates of this much-needed reform was Mr. Elwood Mead, M. Am. Soc. C. E., State Engineer of Wyoming, and it is pleasing to note that the labors of himself and his associates are bearing fruit, and the order has been issued to begin the new plan of monumenting in the State of Wyoming. A former assistant of Mr. Mead, Mr. McFarlane, is now running a line of levels from the Union Pacific railway, at Cheyenne, as a base, to an undeveloped irrigation district in and about Laramie County. Iron monuments are to be set at the township corners and their exact elevation established and permanently marked upon these monuments upon brass plates. Another party has commenced a similar work in the Big Horn, and a portion of the Shoshone basins. The subject of the monumenting of the Government surveys was discussed in our issue of Feb. 27, 1896.

A question of engineering ethics which frequently comes to our attention relates to the credit which an engineer who actually carries out a piece of work should give to a predecessor who has been connected with it in its preliminary stages. The obvious answer is, give exactly the credit due by stating the facts in the case. There may be exceptional circumstances which appear to demand a variation from such a rule, but on the whole it seems to be the only right course to follow. The main reasons which might be urged for pursuing a contrary course are: (1) That where an engineer designs and carries out work with practically no reference to previous reports or plans, or even when following only their general outlines, there is no reason for sharing with another the credit for the work; and (2) that an engineer in relating how he stepped in where another had begun may seem to be exulting over his predecessor. The answer to such arguments is that giving due credit never hurts any one in the long run, even when given with more generosity than the bare facts require, and that the facts in these cases are seldom such that they cannot be stated without giving any real cause for offense.

A case in point has recently come up in connection with the water filtration plant at Lambertville, N. J., described in our issue of July 2, 1896. The writer of the article, Mr. Churchill Hungerford, stated that he was the engineer for the plant and made no reference to the connection of any other engineer with the work. Our attention having been called, later, to the fact that Mr. J. B. Rider had something to do with the work at the start we addressed him on the subject and submitted his reply to Mr. Hungerford, who in turn has stated his case and supplemented it by a letter from one of the directors of the Lambertville Water Co. The whole correspondence on the subject is too lengthy and of too little interest to our readers to warrant its publication. We therefore present instead the main facts in the case as we gathered them from the letters submitted as follows: Mr. Rider made a report recommending sand filter beds, prepared designs for them and set some stakes for cuts and fills. He prepared to take the contract for the work and Mr. Hungerford was, apparently, on the ground to serve as his assistant, when on account of financial conditions Mr. Rider was unable to close the contract. The water company then engaged Mr. Hungerford as engineer and constructed the beds on its own account.

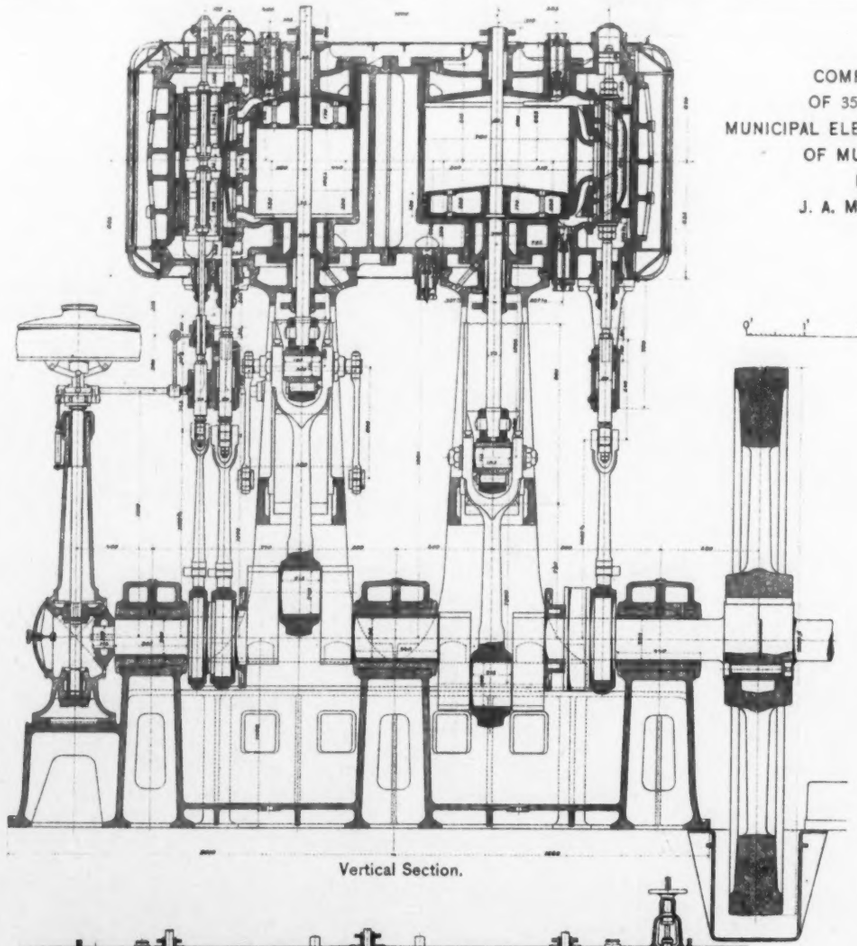
The general plan recommended by Mr. Rider was followed, but it was varied in its details. Of the most important modifications both parties agree that Mr. Hungerford made some, and Mr. Rider claims that some had been previously discussed by him and the water company. Both engineers undoubtedly deserve credit for their connection with the work.

Promotors of ship canals and possible investors in canal securities would do well to closely study the experience of the builders of the Manchester ship canal. The Cotton Association of that city now admits that if those interested could have anticipated all the difficulties that have been encountered, it is safe to say, that the canal would never have been built. The cost was just about double the original estimates, though these seemed very reasonable at the time, and the chief object for which the canal was constructed, that of transferring the great cotton market from Liverpool to Manchester, has not been realized. But while the canal shares return no dividends to those who supplied the funds actually used in construction, the City of Manchester incidentally derives benefit from the reduction in port dues and railway rates caused by the competition of the canal and by the rapid increase in the direct shipment of goods of all kinds from Manchester. The two things made plain by this enterprise are that preliminary estimates of cost and revenue are often misleading, and that it is an exceedingly difficult task to attempt to change the location of a long and firmly established trade. The existence of the canal is doubtless indirectly beneficial to Manchester; but this benefit has cost the canal shareholders about $70,000,000, and they must find what profit and satisfaction they can in thus doing good to some one else. This is not, however, the class of dividends they were led to expect by the original promoters of the scheme; and it is still a question whether like results to Manchester might not have followed the investment of the same sum in other directions and for other purposes, with some profit to those who took the risks of the enterprise.

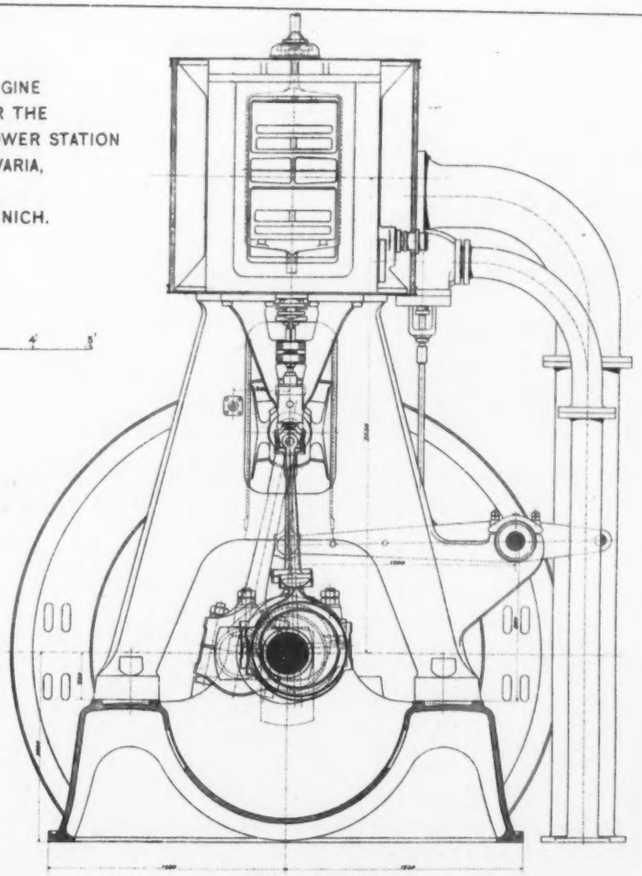
THE STREET RAILWAY TRACK OF THE FUTURE.

Ever since the electric motor began to displace the horse as a motor for street cars, the managers of street railways have been engaged upon the problem of how to make a durable track, and in their study of it have expended sums reaching into millions of dollars. The old-fashioned horse cars cheerfully bounced along over the old flat rail laid on a stringer; and at the speeds at which they ran, the rough joints and the rattle and noise of the car as it passed over them were endurable. The advent of the electric car sent this type of rail out of use; it had already been discarded in progressive cities. But no one in the early days of electric traction dreamed of making a track which should exceed that of any steam railway in strength and stiffness. The old flat rail, with no pretence to longitudinal stiffness, had done duty, after a sort, so long, that a railway track with light ties, spaced rather far apart, and with rails of 50 to 60 lbs. per yd. was supposed to be ample for the heaviest street car traffic. But there were several things that were not taken into account. The first of these was the weight of the motor, resting directly upon the axles, and producing a hammer blow at every joint; the second was the high speed of electric cars, and the third was their great weight com-

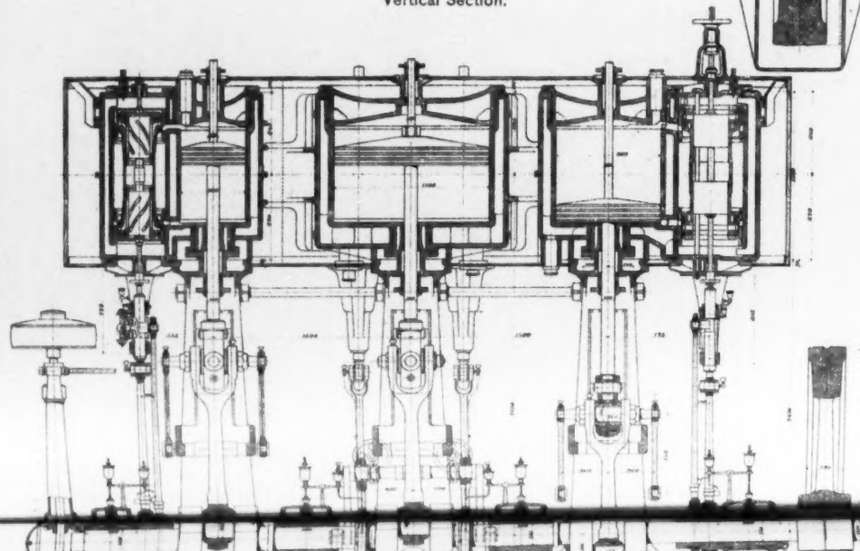
COMPOUND ENGINE
OF 350 HP. FOR THE
MUNICIPAL ELECTRIC POWER STATION
OF MUNICH, BAVARIA,
BUILT BY
J. A. MAFFEI, MUNICH.



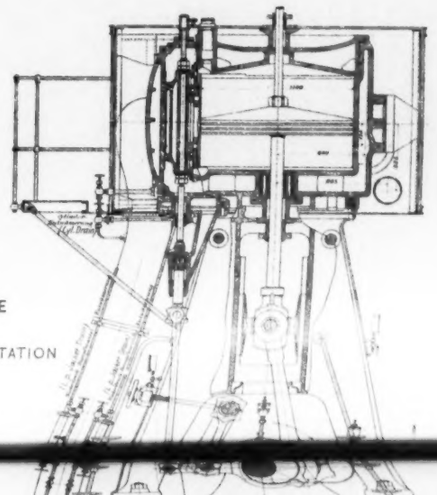
Vertical Section.



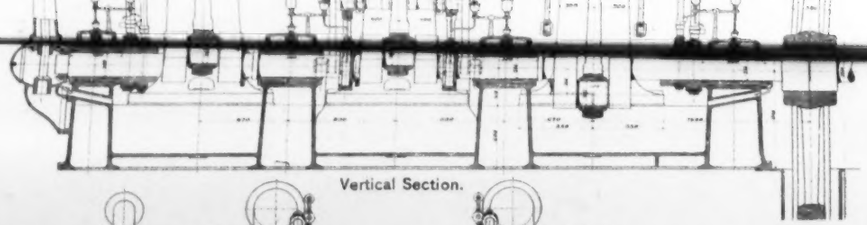
Sectional Side Elevation.



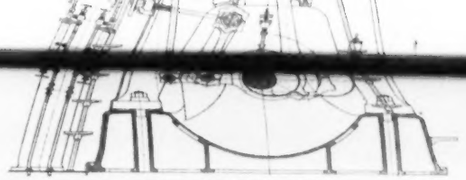
TRIPLE-EXPANSION ENGINE
OF 700 HP. FOR THE
MUNICIPAL ELECTRIC POWER STATION
OF MUNICH, BAVARIA,
BUILT BY
J. A. MAFFEI, MUNICH.



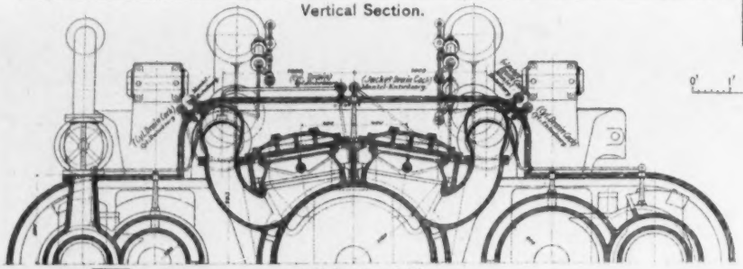
BUILT BY
J. A. MAFFEI, MUNICH.



Vertical Section.



Sectional Side Elevation.

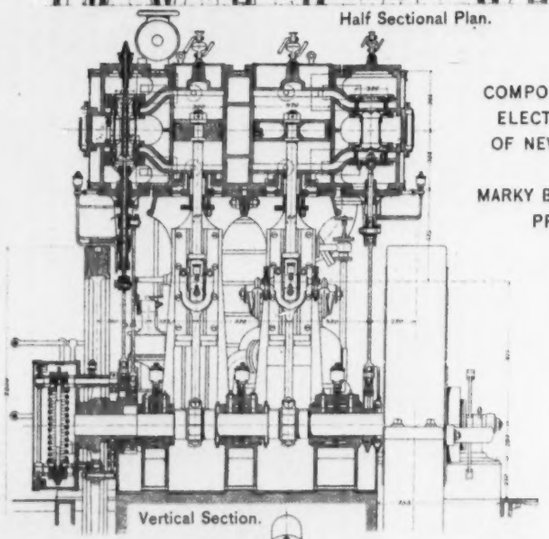


Half Sectional Plan.

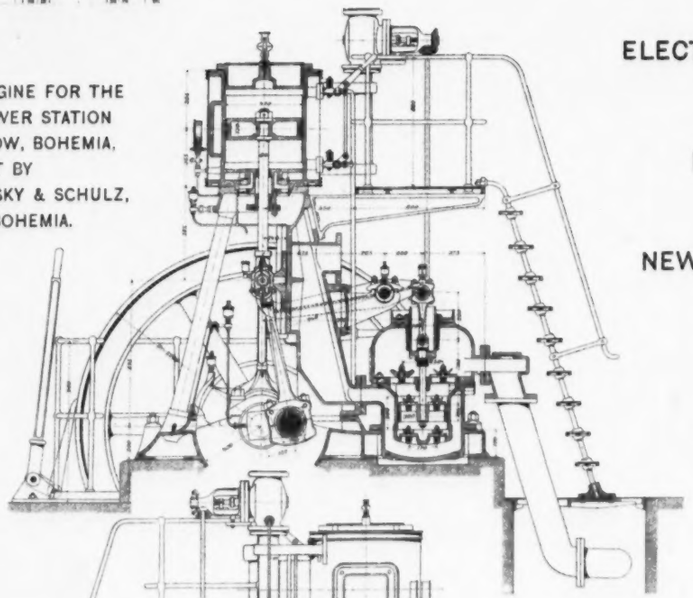
ENGINES FOR ELECTRIC POWER STATIONS, IN MUNICH, BAVARIA, AND NEW BYDZOW, BOHEMIA.

(Reprinted from the Journal of the Society of German Engineers.)

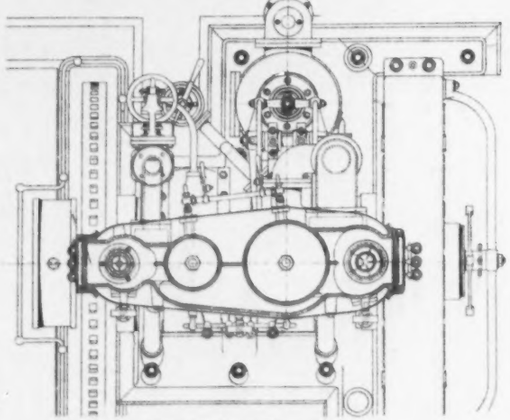
COMPOUND ENGINE FOR THE ELECTRIC POWER STATION OF NEW BYDZOW, BOHEMIA, BUILT BY MARKY BROMOVSKY & SCHULZ, PRAGUE, BOHEMIA.



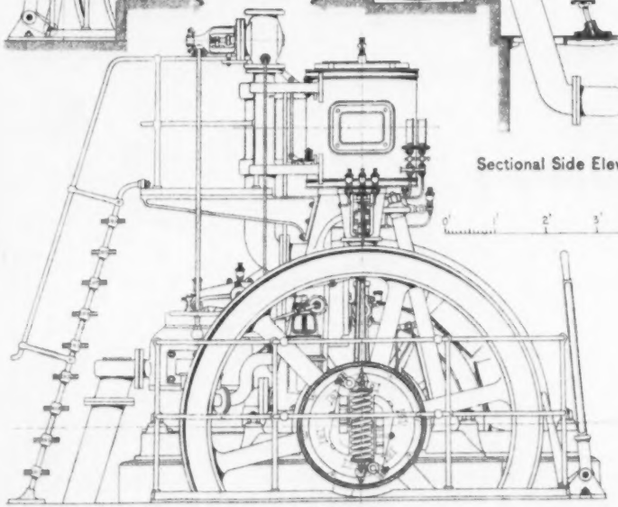
Vertical Section.



Sectional Side Elevation.



Part Sectional Plan.



Side Elevation.

CHAS. HART & SONS, LITHO., 30 VESEY ST., N. Y.

pared with the weight of horse cars. The combined effect of these factors was to make life a burden for the engineer responsible for track maintenance on electric railways. It was seen very soon that an electric railway required a heavier track than that above described, and the laying of girder rails was begun. The depth of these went from 5 ins. up to 6 ins., 7 ins., even to 10 ins., and the weight was proportionally increased. Of course with every increase in depth of rail an increased depth of foundation became necessary, which meant more excavation and placed the ties further underground. The net result is that the track of a street railway, which, in the old horse-car days, was a very light and inexpensive structure, is nowadays an exceedingly heavy and costly construction; and notwithstanding this, proves by no means so durable as was hoped when the heavy girder rails were first introduced

It is difficult to understand why electric cars should be so severe on the track, and especially upon the rail joints. This is usually ascribed to the electric motors, which were formerly mounted directly on the axles. Nowadays it is customary to support as much of the weight of the motor as is practicable from the truck frame; but with the increase in size of electric motors there is still complaint that the rail-ends are pounded down. Why should an electric car be more severe on the rails than a steam locomotive? Take, for example, a modern high-speed steam locomotive for heavy service. There is the driving wheel, 6 ft. or more in diameter, the weight of half the driving axle, and one eccentric, the weight of the axle-box and part of the spring, and finally the weight of the parts attached to the wheel, which, in case of the main driver are the crank-pin, counterbalance weight, half the weight of the parallel rod and more than half the weight of the connecting rod. When we have summed up all these weights, we find a total load on the rail not supported by springs which may equal or exceed the load that is not spring-supported on an electric car-wheel tread. Further the electric car may run at an average speed of 8 or 10 miles per hour, while the locomotive averages three or four times this; why, then, should not the locomotive be more severe upon the tracks than the electric car? Again, it is to be remembered that the cable railways also experience more or less trouble with their track-joints, though not as much as the electric lines. It would appear from this that the conditions under which street railway track is laid and maintained, may have something to do with the joint difficulties. Perhaps the fact that on a railway in a paved street the joints are let alone until their condition becomes so bad as to compel the removal of the paving to make repairs, has something to do with the troubles experienced. On steam railway lines, as is well known, the way to keep track in good condition is to constantly take the "stitch in time" that saves nine.

A very good proof of the serious nature of the joint problem on street railways is furnished by the radical treatment that has been accorded to it. The possibility of the use of continuous rails on steam railways was broached years ago; but it remained for the street railways to actually test the idea and prove its practicability.

At present there are in use in this country from 150 to 200 miles of street railway track, the joints of which have been all welded, either by the electrical or the "cast-welding" system, so that the rails are actually continuous. As to the success of this system, the testimony is rather conflicting; but the fact appears to be that the difficulties encountered have been no more serious than might naturally be expected to accompany so novel a departure from usual practice. The cast-welding system promises to supersede the electric welding system, according to our best information, because it produces as good or better results, at a less cost. Unless some further trouble should develop or those already found should prove more serious than they thus far have done, it seems quite probable that the street railway track of the future will have a continuous rail, at least wherever it is laid in paved streets.

Turning now to the foundation on which the rail rests, we find that the heavy punishment to which street railway track is subjected, is made evident here as well as at the rail joints. With heavier rails have come larger ties, more closely spaced, and of late there is a growing tendency toward the use of concrete in foundation work. All this means heavy expense; and it is a serious question whether the street railways of the country are at the present time getting the service from what we may call the sub-structure of their track that they should receive for the money they have expended upon it.

It is true in this department of engineering as in many another, that progress is in the nature of an evolution. The present street railway track has been evolved from the tracks of the steam railways. In the field of organic evolution we often see a bodily structure with members which no longer serve a useful purpose, but are traces of the structure of some ancestral race. In a similar way it is at least possible that in the evolution of the street railway track from that of the steam railway certain features have been retained which no longer serve their original purpose.

Let us see what qualities the ideal rail support on a street railway should possess. Its office, of course, is to spread the weight which it carries over a sufficiently large area to support the load without settlement. Whether in addition to this it should have a certain elasticity is a question which is undecided. There is, indeed, a general belief that the rail must have an elastic support; but it is unquestionable that the necessity for the elasticity arises mainly from the imperfections and inequalities in the foundation. Thus on cable railways the rails have been carried directly on the cast-iron yokes and no harm has resulted to either rails or rolling stock.

On a steam railway line the rail supports must fill several other requirements. They must keep the rails to gage; they must hold them from canting; they must permit the rails to be readily fastened to them; they must allow of quick repair and replacement in case of derailment or other accident injuring the permanent way. Now, all these requirements obtain in much less degree if at all, on a railway in a paved street. The paving itself holds the rails to gage and keeps them from canting, and the necessity for secure anchoring of the rail to the foundation is merely to prevent any hammering action taking place. Further, a derailment or other accident in a paved street cannot injure the rail supports.

We may now ask the question, why do we use cross-ties to support the rails of a street railway? Is it because they form the best and most economical support that could be devised, or is it, perhaps, because cross-ties have been used for rail supports almost universally since the first use of the railway? Is it not at least possible that a longitudinal system of rail supports for our street railways might prove more economical and durable, and reduce the cost and difficulty of track repairs? Again, is it necessary to bury such a large amount of wood beneath the pavement of a street railway as we do at present? Decay begins in it, we know, before it has been long in place; and with decay, settlement is inevitable, and this settlement will be by no means uniform. A rail in bad surface, and the entry of water and frost to the track foundation are the certain result.

In view of these defects of the cross-tie system of rail supports on street railways it is worth while asking whether we do well to adhere to it. Cannot a system of longitudinal foundations be designed which will give a continuous support to the rail, and which will fill all requirements better than the present system. Why not lay along the line of each rail a solid foundation of width sufficient to carry the required load without settlement, and either lay the rail directly upon it, or else, if some elasticity is found to be essential, interpose a stringer of wood as light as will give the required cushioning effect. In European practice it is very common to lay girder rails directly upon the concrete foundation of the street.

The first cost of such a system of rail supports would, perhaps, be a little greater than that of the present cross-tie system; but it seems probable that the reduced cost of track maintenance would much more than offset this. It will be apparent at once that with such a system repairs could be made on one rail of the track, or its supports, without at all disturbing the other and without removing the pavement at the center of the track.

If the street railway track of the future is to be made on the present system of cross-tie supports, it will only be because that meets the practical requirements better than any other. It is because the burying of a nearly continuous pavement of perishable and rapidly decaying wood beneath the tracks of a street railway appears to us to be an anomaly, that we have thought it wise to call attention to it, and to suggest the possibility of a better system. We know that in the process of organic evolution the organs which are inherited from former generations, but which are rendered useless by change of environment, continue for a time, and then gradually disappear. So in the case of the street railway tracks, if the system of cross-tie supports is a mere inheritance from earlier railway practice, we may expect to see it gradually disappear and something better will take its place.

LETTERS TO THE EDITOR.

Operating Steam Pumps without Oil in the Steam Cylinders.

Sir: We have recently noticed an article in your paper in regard to steam pumps operating without oil in their steam cylinders, in which credit was given to one of the manufacturers for having been the first and only company to adopt this practice. The machines referred to were very recently constructed and tested. It will doubtless be a matter of general interest to know that the Deane Steam Pump Co., of Holyoke, Mass., have built several hundred machines during the past two or three years expressly for operating without any oil in the steam cylinders. The pumps have been operating successfully and a large number of users report their operation as entirely satisfactory. The pumps referred to are all of them horizontal machines of the duplex type. Yours truly,

The Deane Steam Pump Co.
L. E. Bellows, General Manager.

Holyoke, Mass., Oct. 16, 1896.

Credit for the Johnson Electric Lighting Plant.

Sir: We have read with considerable interest your account of the electric lighting plant at Johnson, Vt., in your issue of Oct. 8. This plant was laid out by our Mr. Almon and it was on his suggestion that incandescent lamps were used rather than arc. We were the contractors for the entire electrical equipment and would have been glad to have had some mention in your article. We have also put in similar plants in Morrisville, Northfield, Bethel and Montpelier, all of which will show up very well in income and operating expenses. Very truly yours,

Almon, Sargent & Conant.

106 Equitable Building, Boston, Mass.

(Our apologies are tendered for the omission. It is the established custom of this journal to give full credit to both engineers and contractors in the description of any piece of engineering work. It was an oversight that it was not done in the above case.—Ed.)

The Weight of the Park Row Building.

Sir: In your issue of Oct. 8, 1896, in speaking of the Park Row Building in your editorial column, you say:

"Probably the entire weight of the building when completed and occupied is not less than three times the weight of the steel in its framework, or a total of 18,000 tons."

The estimated total weights are as follows:

Weight of building	56,200 tons.
Weight of steel	9,000 "
Total	65,200 "

Yours very truly,

Nathaniel Roberts, M. Am. Soc. C. E.

Jersey City, N. J., Oct. 12, 1896.

(We thank our correspondent for the correction. Our comparison of the weight of the steel framework and the weight of the structure was really only a guess, and was purposely placed at the minimum which we thought possible, and a "slip of the pen" made the figures even less than they should have been. But the correct figures for the weight of the structure given by Mr. Roberts make still more forcible the point which we desired to make, viz.: the immense mass and weight of such a structure compared with the force which the most severe windstorm could exert against it. —Ed.)

Deep Borings for Foundations in New York City.

Sir: It may be of interest to record that a depth of 115 ft. was reached by boring on the site of the Tombs, without reaching rock. Boring was discontinued at this depth, because piling will be used in the foundations of the new prison, and we found satisfactory material for this purpose.

Another hole was driven to 90 ft., and discontinued, no rock being reached, while two others were bored to a depth of 80 ft., and were stopped by the rock. This shows the varying levels of the gneiss rock formation.

The bed of the old pond which existed formerly at this place was reached at from 30 to 40 ft., peat and other vegetable matter being washed up.

The material throughout in all test holes was gravel of a varying coarseness and sand. Particles of the old timber footings of the present prison were met with and washed up, having been cut by the pipe, and the old pine was as fresh as the day it was put in, 60 or 70 years ago.

The depth at which rock was struck in the latter holes (namely 80 ft.), corresponds very closely with the rock level met with in the borings taken not 100 ft. away, on Elm street by Mr. W. B. Parsons, Chief Engineer of the Rapid Transit Commission. This was I think about 84 ft.

Very truly yours,

F. S. Williamson, M. Am. Soc. C. E.

(Engineer to the Architects, Messrs. Withers & Dickson.)

Broadway, New York, Oct. 5, 1896.

Plants for Long Distance Power Transmission.—Correction.

Sir: Referring to your issue of Oct. 8, I find two typographical errors on page 231, in the list of plants in Dr. Duncan's address on "The Present Status of the Distribution and Transmission of Electric Energy." The line-voltage of the Pomona and San Bernardino plant is given as 1,000 volts, whereas it should be 10,000 volts. Again, the plant at Rome is credited with a distance of 188 miles, instead of 18.8 miles. When these corrections are made, the Pomona plant is seen to occupy its true position as the first plant in this country to use such a high pressure as 10,000 volts, and also to transmit power over so great a distance. The Pomona plant owed its origin directly to the success of the experimental plant temporarily put up between Lauffen and Frankfort, and was watched with great interest by engineers and investors as being the first plant in any country to commercially use such a high voltage over such a great distance. The construction and operation of this plant, of which I was engineer in charge, is fully described in the Transactions of the American Institute of Electrical Engineers in my paper on "Long Distance Transmission at 10,000 Volts." read in June, 1895. Yours truly,

G. H. Winslow.

Lewis Block, Pittsburg, Pa., Oct. 12, 1896.

(The errors referred to were in the copy of Dr. Duncan's paper, furnished to us for reprinting. We may note also that copies of the paper by Mr. Winslow were printed separately from the Electrical Engineers' "Transactions," and we presume can be obtained by any of our readers by addressing him as above.—Ed.)

A Neat Pamphlet Filing Case.

Sir: I send in this mail a pamphlet case for engineers which I designed for my own use and had manufactured by Mr. C. A. Brackett, of this city. It is the result of considerable study, after failing to find anything in the market to suit my ideas. For municipal reports, and as a temporary binder for the Journal, it is just what I want at a moderate price, $3 a dozen, and may be desired by other engineers. Yours truly, Edward P. Adams.

53 State St., Boston, Mass., Oct. 8, 1896.

(The case sent by Mr. Adams is a neat pasteboard box, $7 \times 9\frac{7}{8} \times 2\frac{3}{4}$ ins., inside measurement, designed to stand on end, with a flap back cover, opening up, and shutting into the case. The edges are reinforced, and the cover is entirely covered with black cloth. The cover forms the back of the case, and has printed on it in gilt "Engineering and Municipal Reports and Papers," and below, "Vol.," with an enclosed space for the number. A gummed label accompanies the case, which can be used for the volume number, or any other brief designation desired. The construction of the case renders it as nearly dust proof as possible. A number of different styles of cases are made by the Library Bureau, of 280 Broadway, New York, and with offices in Boston, Philadelphia, Chicago and St. Louis. Some of these cases are cheaper, and some more expensive, than the one described above. Most of the cases are made of wood, and thus are more durable than the one sent by Mr. Adams.

We have used for some years past filing cases about $8 \times 10\frac{1}{2} \times 4$ ins. of ordinary pasteboard, made up with black cloth, and having white paper pasted over the whole back, for titles. These boxes have no covers, and cost only some 5 cts. apiece. Similar ones can be obtained, we suppose, from any manufacturer of paper boxes.—Ed.)

Railway Commissions and the Issue of Stock and Bonds.

Sir: I read with much interest in Engineering News of Sept. 24 your notice and editorial comment on the late hearing of the Maritime Coast Company's application for the approval by the Massachusetts Railway and Harbor Commission of $6,000,000 stock and $6,000,000 bonds.

Your remark that Massachusetts is far in advance of other states in her laws regulating the issue of stocks and the marketing of bonds, while perhaps correct, should have included a notice of the Texas Stock and Bond Law of 1892, which antedates the Massachusetts law by two years, and which, judging by your synopsis of the proceedings referred to, seems to be identical in intention and effect. Texas has been more than generous to railway corporations during the past 25 years, and yet has incurred the pretended ill will of interested promoters and anti-promoters on all sides for her simple and statesmanlike regulation of the issue of bonds by both municipal and railway corporations. Permit me to refer you to your appreciative review of the operation of the latter laws in your issues of March 7, 1895, and April 23, of this year.

Just as ever, opinions depend very greatly on whose ox is being gored. I dare say that the Massachusetts folk consider their law a patriotic advance in statemanship, and yet from that same neighborhood has come the cry against "legislation inimical to capital," which has been alleged, without the slightest foundation in fact, against the fair name of our state.

It is gratifying to see that technical papers of your standing are taking the just position in the public interest which your remarks indicate. "Engineering" takes the same view of the question, and particularly as it relates to our state. The subject was discussed at length in the issue of Feb. 14 of the current year.

Yours respectfully, C. Corner,

Assoc. M. Inst. C. E., Assoc. M. Am. Soc. C. E., Expert Civil Engineer R. R. Com. of Texas.

Austin, Tex., Oct. 3, 1896.

(We owe our apologies to the Railroad Commission of Texas, for our omission to include that state with Massachusetts in the list of those seeking to reform past methods in the issue of stocks and bonds. Our editorial of March 7, 1895, treating of the Texas law and referred to by Mr. Corner, plainly sets forth our position upon the general question.—Ed.)

Experiments on Pumping from Artesian Wells at San Jacinto, Cal.

Sir: The writer was engaged during the winter of 1896 in the construction of a water system at San Jacinto, Cal. The supply was taken from three 7-in. artesian wells, located in the artesian belt which extends from near the mouth of the San Jacinto River canyon northwesterly a distance of several miles. The deepest well was 350 ft. and pierced alternate layers of clay, gravel and sand. The wells were cased with two thicknesses of riveted pipe, and the pipe was cut after the fashion of the region, in all water bearing sand, by a series of gashes, ¼ to ¼-in. wide by 8 to 12-in. long, four in a ring, and the rings 12 to 16 ins. c. to c. The total thickness of water bearing sand in which the pipe was cut was about 170 ft. in the three wells.

The pump installed was a compound, duplex Worthington, with 12-in. plungers. The wells were about 50 ft. apart, each having a 6-in. suction pipe lowered into it about 30-ft. below the pump, all three being connected to a 10-in. suction main from the pump. A vacuum gage was attached to the vacuum chamber near the pump. At the time the pump was started the water would rise about 5 ft. above the pump and the three wells flowed at the ground surface about 50 gallons per minute. Readings were taken simultaneously of the vacuum gage and the speed of the pump and plotted after adding the head of water above the pump.

The result shows that the yield increased very nearly in proportion to the depth to which the water was lowered below level at rest, until the limit of suction was approached. A similar result was obtained with a centrifugal pump on a single well. The yield of the three wells was about 1,100 gallons per minute, as a maximum, with suction about 23 ft. below the pump.

The effect on nearby wells was noted as follows: A well 200 ft. away was lowered 3.1 ft. after five hours' pumping, the pump taking water 22 ft. by gage. A well 1,800 ft. away, across the drainage lines, fell about 0.1 ft. in one hour and 0.45 ft. in a little over three hours, and the greatest noted difference was 1 ft. after four hours' pumping. A well 700 ft. away, up stream, fell 1.7 ft. after five hours' pumping. A well 3,600 ft. away showed a decrease of flow in about five hours after the pump started, but no measurements were made.

Apparently the water pressure was lowered over a large area and the water slope to the well was very flat. After a day's run the water would stand about 3 ft. lower than at the start, the same as the amount of fall in a well 200 ft. away, and the conclusion reached was that the flow was limited, not by lack of water in the ground, but by want of sufficient entrance area into the pipes or by a clogging by sand near them. A twelve-hours' stop would bring the water back to its former level, save that the general level was falling about 0.5 ft. each month.

E. F. Tabor.

Escondido, Cal., Sept. 30, 1896.

A Schedule for Engineers' Charges.

Sir: I have read with interest the recent discussion concerning "cheap engineers," in your paper, and not wishing to lower the profession by cutting prices below what they should be, I would be glad to see a schedule of prices for some of the more common work which an engineer might be called upon to do, in a city of 7,000 inhabitants.

What would be a fair salary for city engineer in such a town? Sewer work and paving are just commencing. About what is the charge for laying out new additions, for running sidewalk grades and for surveying lots?

What per cent is usually charged for designing and superintending a system of sewers? What on masonry and steel bridges?

What is it worth to design a grade system for a town covering 2 sq. miles of territory with the blocks about 300 ft. square? The town is slightly rolling, with a stream through the center about 20 to 50 ft. below the land on either side.

If you will kindly answer these questions you will confer a great favor upon me, and doubtless upon many other young engineers, who, though they are competent to handle the work they undertake, often do it too cheaply simply because they do not know how much to charge for it. Very respectfully,

———, Iowa, Oct. 3, 1896. O. E.

(Our correspondent's query is certainly a pertinent one. If cutting prices below what they should be is to be condemned by the profession, it is proper to inquire what prices should be asked for engineering work. There is no schedule of fees in general use by engineers, and the great difference in conditions between the engineer working in a small country town and the engineer working in a large city make the preparation of a schedule that would be of general application difficult or impossible.

In general the engineer in fixing a price for his work should consider two things. First, what is it actually worth to the party for whom it is done? The answer to this question will fix the maximum price that could be asked for the work. Second, what does the work actually cost the engineer, in time, expenses, tools, assistance, etc.? This should fix the minimum. Of course the answer to both these questions will vary greatly in different parts of the country, in places of widely varying population, or when the same piece of work is concerned, the question would be answered differently by engineers of varying experience, reputation and commercial push. If any of our readers can furnish answers which will better meet the needs of our correspondent, we shall be pleased to hear from them.—Ed.)

The Sewerage and Sewage Disposal Systems of Plainfield, N. J.

Sir: Referring to the article entitled "The Sewerage and Sewage Disposal Systems of Plainfield, N. J.," in your issue of Sept. 10, may I ask you or some of your readers the following questions:

(1) If "self-cleansing" means to carry off all solid matter which may enter sewers; is a grade of 1 in 1,200 for a 24-in. sewer, 1 in 900 for an 18-in. sewer, etc., self-cleansing? (2) Are not 6-in. branches for house connections better practice than 4-in. branches? (3) Are not the distances between the manholes, for the size and grade of sewers mentioned, too great?

Being familiar only with the combined system of sewers, the grades and distances between manholes on such small sewers appear strange to me. Respectfully yours,

South Norwalk, Conn., Oct. 5, 1896. B.

(Familiarity with the combined system, only, doubtless accounts largely for the raising of the above questions, as our correspondent himself suggests. It is explained in the articles that the minimum grades adopted for main sewers were chosen in order to serve as large an area by gravity as possible. The grades were not selected arbitrarily and numerous flush tanks have been provided on the system. To put it strongly, the only

reason for making ordinary house connections larger than 4-ins. is to give more leeway for careless servants and householders in the use of the sewerage system for the disposal of garbage, old clothes and waste metal. While larger house connections lessen the danger of stoppages by such matter they increase the deposits of organic matter by reducing the depth of flow in the sewer. Some engineers prefer 6-in. house connections, and a compromise is sometimes made at 5 ins.

The distance between manholes is given in the article as, in general, 400 to 500 ft. on mains and 700 ft. on laterals, with lampholes 200 to 300 ft. apart between the manholes on laterals, but with the important statement that manholes are placed at all junctions, changes of grade and alinement. In a separate sanitary sewerage system, properly designed in other particulars, it would seem that manholes placed as at Plainfield ought to be ample. There should be practically no deposits of organic matter and no foreign matter of sufficient size to make a stoppage should ever reach the sewer. As the stoppages must almost inevitably come from the houses, one advantage in having the house connections small is that it is then possible to determine who is responsible for stoppages, and provide and inflict a punishment to fit the crime.—Ed.)

Hydrographic Surveys on the Outer Bar of Brunswick, Ga

Sir: In your issue of Oct. 1 there appears an article entitled "An Experiment in Dredging with Dynamite," in which I am quoted as "an engineer employed by Mr. Goodyear" in such a way as might give the inference that the results of my investigations on Brunswick Bar were on that account prejudiced in favor of the contractor. It appears also that the conclusions reached in the article referred to are the results of an investigation of only a part of the facts. It seems to me, therefore, that it is due to your readers, who I may presume are largely the civil engineers of this country, that you should publish the other side of this matter, and I therefore send you herewith a copy of my report on this subject with the hope that you will deem it of sufficient interest to your readers to publish it in full.

I would also beg to remind you that when this matter was before the River and Harbor Committee during the last session of Congress in which Captain F. V. Abbot was present and attempted to defend the report of the Board against adverse criticisms, it was the unanimous vote of the committee to ask the Honorable Secretary of War to reconvene the Board for the purpose of reconsidering its conclusions. It would, therefore, seem evident that your conclusions in this matter are not the result of a full investigation of all the facts. Very respectfully,

Galveston, Tex., Oct. 6, 1896. H. C. Ripley.

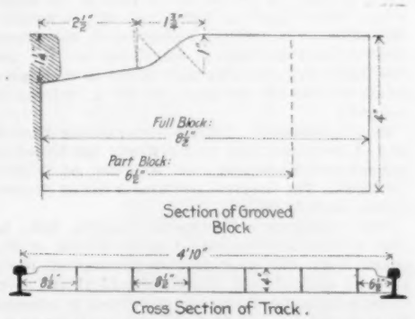
(We certainly did not intend to convey the impression that Mr. Ripley's survey and report on the depth of water on the Brunswick Bar was prejudiced in favor of the contractor. Nor did we intend to enter at all into the differences between the survey made by the Board of Engineers and that made by Mr. Ripley. Our conclusions as stated in the article were reached from a careful examination of a large mass of papers and documents furnished to us by Mr. Goodyear. If there are other facts more favorable to his process than those which he furnished us, we shall be pleased to have them presented to us.

The report of the Board of Engineers which made the survey of the bar and the report of Mr. Ripley upon his own survey and in criticism of the methods and results of the Board are very interesting documents but are, we regret to say, too long for reprinting in our columns. We advise any of our readers interested in hydrographic surveying, however, to secure copies of these reports, which we presume they can obtain by addressing Mr. Ripley as above, or Col. C. P. Goodyear, Brunswick, Ga. We may remark, as a matter of interest, that Mr. Ripley enumerates eight common sources of error in making soundings, and discusses the influence of each in the case under consideration.—Ed.)

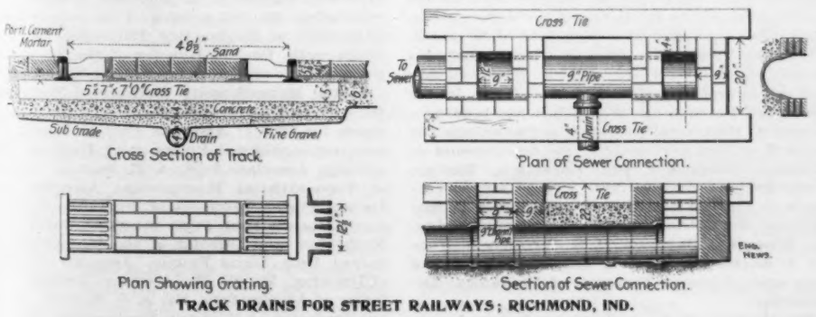
A VITRIFIED BRICK PAVEMENT, on McDonough St., in Brooklyn, is to be torn up and replaced by asphalt, in response to continued complaint of the great noise resulting from traffic over this particular street pavement. Other streets in Brooklyn are paved in a similar manner, but are used without the peculiar "roaring sound" complained of by the residents of McDonough St. As these pavements, we understand, are laid on concrete with a sand cushion between the concrete and the brick, there seems to be no evident cause for the noisy quality objected to. It would be interesting to note whether a similar cause of complaint has been found in other cities and we would be pleased to hear from readers having any such experience. Cheapness, smoothness and a practically noiseless roadway, as compared with stone blocks, are the chief advantages claimed for vitrified brick pavements; and for use in thickly-built-up cities the third claim is a very important one.

PAVING ALONG STREET RAILWAY TRACKS.

The method of paving a street at Cortland, N. Y., so as to leave a flangeway for the wheels of electric cars running on a track laid with T-rails, was shown in our issue of Sept. 3, and this has brought us some communications on this subject of paving street railway tracks. Mr. H. L. Weber, City Engineer of Richmond, Ind., has sent drawings showing the track construction and special brick or block for T-rail track, as used in that city. The special brick are of different lengths, consequently all joints are broken. On the outside of the rails Portland cement mortar is filled in under the head, so that the paving next to the rail has a full bearing, the same as at the curb. The special blocks form a groove along the rail and if the track work is properly done this is considered as desirable as the grooved head. The street surface is as continuous as it is possible to make it with a railway track upon it. The track drains are placed at intervals of 400 ft. and at points of break of grade.



Brick Paving For Street Railway Tracks; Richmond, Ind



TRACK DRAINS FOR STREET RAILWAYS; RICHMOND, IND.

Mr. H. P. Jones, of Steelton, Pa., writes as follows, in regard to the article in our issue of Sept. 3:

The suggestion of the molded brick is excellent, but would be a useless expense to incorporate in the Cortland plan, where every rail chair is in practice a water conductor to the reservoir which in six months' time will be formed under the concrete at the ties, and finally extending under the entire track system. It does not require a scientifically-trained mind to forecast the result when this reservoir becomes frozen solid.

The first intimation to be had that the foundation will give way, will be that the bricks next the gage side of the rails will have a tendency to stand on end; the patrons of the railway will be treated to a very unpleasant sensation while riding, and the stockholders will be wondering why the management is continually purchasing new wheels. The chief advantage of a concrete base for a pavement, over any other kind, is its stability, making maintenance and renewals a minimum cost. When that end is not attained, the money has been thrown away. I do not believe the Cortland plan is based on engineering principles.

ELECTRIC LOCOMOTIVE ON THE MANHATTAN ELEVATED RAILWAY.

As stated in our issue of Oct. 8, a trial of electricity is being made on the 34th St. branch of the Manhattan Elevated Ry., in New York city. The line is only a few blocks in length, extending from the Third Ave. line to the Long Island Ferry.

The motor car was designed by Mr. J. B. Entz, representing the Storage Battery Co., of Philadelphia. The trucks are from a dummy engine, the drivers being 28 ins. diameter. The body of the car is 18 ft. long, and 8 ft. high, in the center, where the motorman's cab is placed. From the cab the roof slopes in either direction to a height of 3 ft. at the ends. The weight is ten tons. A 400-volt current is supplied from a third rail, of T section, placed on the outside of and at an elevation of about 10 ins. above the track rails. Contact is made by two cast-iron sliding shoes, hanging loosely from the front and rear axle bearings of the trucks. The idea of the two shoes, as explained by Mr. Entz, being to fortify against breaks in the contact, which might occur by the jumping of a single shoe.

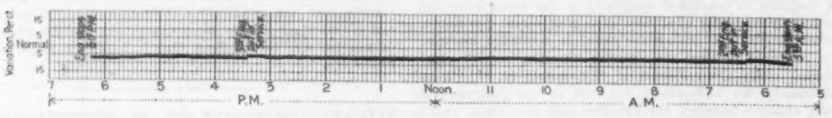
The electrical equipment includes two General Electric motors, each of 125 HP., and storage batteries of 256 cells, weighing 80 lbs. each. These cells are constantly in parallel with the power-house circuit and are intended to equalize the load. When no power is needed, as on a down grade, the current is consumed in charging the batteries; when the load is heavy, the extra current required is supplied from the storage batteries. This has the effect of making the dynamo load more uniform, or of maintaining a constant load on the generators, independent of the variable current required by the locomotive. This permits the use of smaller machines at the central station, and a consequent saving of coal. The location of the batteries in the power-house would in the same way equalize the central station load, but the fluctuations would still be felt in the distributing conductors. By placing the storage battery on the locomotive at the exact point where the sudden fall of potential occurs at the time of heavy demand for power a steady current is maintained in the line conductors; a sudden demand, as in starting, for a large amount of current is supplied by the battery and no additional demand is made upon the current conductor; both pressure and current remaining constant. In the old system of distribution both machines and conductors must be made large enough for the maximum demand; and the drop in voltage, which occurs at a distance from the power-house, causes the motors to work inefficiently just when the demand for power is greatest. By this method the feeders and conductors can be designed to carry the average load. The conductor at a long distance from the power-house could also be made smaller, the small current in the line being reinforced automatically by the battery.

This system also allows the third rail to be discontinued at crossovers, the load at such places being imposed upon the batteries. The batteries alone will supply sufficient power to operate a train for 15 to 20 miles at a speed of 25 miles per hour.

The first cost of the electric locomotive is said to be slightly above that of the steam locomotives now in use.

AN EXAMPLE OF GOOD SPEED REGULATION BY A LARGE ENGINE.

We reproduce herewith, on a reduced scale, a diagram made by the Moscrop speed recorder of a 13 hours' run of the No. 4 engine at the power house of the People's Traction Co., Beach and Green Sts., Philadelphia. The engine is a twin tandem compound, direct coupled, built by the Edward P. Allis Co., of Milwaukee, Wis. The cylinders are 24 and 48 ins. diameter and 60 ins. stroke. The normal speed is 65 revolutions per minute. On the diagram the distance between any two of the horizontal lines is equivalent to a variation of 5% in the speed of the engine. The autographic record shows a practically perfect regulation, the line drawn by the pencil being almost exactly parallel to the horizontal lines of the diagram. There are no noticeable deviations at any point except where additional engines were started or stopped.



SPEED DIAGRAM FROM AN ALLIS 24 × 48 × 60 IN. ENGINE AT THE POWER HOUSE OF THE PHILADELPHIA TRACTION CO., JUNE 1, 1896.

NOTES FROM THE ENGINEERING SCHOOLS.

Columbia University, New York City, entered upon its 143d academic year on Oct. 5. This will probably be the last year that it will occupy the present buildings, as it is likely that in another year the new buildings on the new site on Riverside Drive will be ready for occupancy. Increases in all departments of the University are reported. Mr. Chas. C. Worthington, M. Am. Soc. C. E., has offered to equip a laboratory of hydraulic engineering in the new School of Mechanical Engineering. The gift is to be made in the name of his father, the late Henry R. Worthington. The following additions have been made to the faculty: Adolph Black, tutor in civil engineering; Chas. Durieth, assistant in civil engineering; Heinrich Ries, assistant in mineralogy. A notable change has been made in regard to the old School of Mines, which will hereafter no longer be known by its old name, but by the name of the School of Applied Science, while the School of Chemistry, the School of Architecture, and the School of Engineering will be set apart as distinct schools, all four schools being under the charge of one faculty, known as the faculty of Applied Science. In his address at the opening of the new year President Low declared that the move toward establishing a school of mechanical engineering was a most important one, since the city of New York was the greatest manufacturing center in the country. He said: "I think it may be said that the removal of the University may take place next year as has been proposed. To facilitate our removal we greatly need at once the gift of a building for physics, costing $250,000; a building for engineering, costing $250,000; a gymnasium, costing, with apparatus, $375,000."

The Missouri Military Academy, at Mexico, Mo., was burned to the ground early in the morning of Sept. 24, while 80 cadets were asleep in the building. About twenty of these were more or less severely injured in jumping from the windows. The loss is estimated at $70,000, of which $40,000 is covered by insurance. The Academy was opened in 1890, and the building was one of the most complete in the State. There is a suspicion that the fire was the work of an incendiary.

The Oregon Agricultural College, at Corvallis, Ore., began its year's work on Sept. 17, under the management of a new president, Mr. H. B. Miller, of Grant's Pass, Ore., who succeeded Mr. John M. Bloss, resigned. Prof. F. Birchtold, of the Department of Physics and History, has been appointed Dean of the College, a newly created office. An "Insectory" has been built for the Entomological and Botanical departments, to aid in the study of the habits and life of injurious insects and fungous diseases. The Experiment Station, so far as possible will bend all its energies along one line at a time, all the departments taking up their phase of the same subject. This year "the Prune," Oregon's great industry, will be given special attention. The mechanical course has one young lady taking all the work of the course, and doing work equal to that of any of the young men.

The University of Wisconsin, Madison, Wis., has a College of Mechanics and Engineering, which offers three separate systematic courses, viz.: civil, mechanical and electrical engineering. Special encouragement is given to those students who can afford the time to graduate in a collegiate course before entering the course of engineering. By electing the mathematics required of engineers during the collegiate course the degree in engineering can be obtained in two additional years. Greater satisfaction and profit is gained from the study of engineering when the student has already acquired a broad and thorough general training. The staff of instruction in the engineering college, including professors, assistants and special lecturers, numbers over forty. Dr. Chas. Kendall Adams, LL. D., is president of the University.

The Newark, N. J., Technical School, which has been in successful operation for some years, will not open until some time in November, owing to delay in the construction of its new building. The school year will be extended later in the spring of 1897, to make up for the loss of time at the beginning. Prof. Chas. A. Colton, E. M., is director. Mr. Maurice A. Miller, instructor in mechanical drawing and mechanical engraving for the last few years will also give instruction in descriptive geometry, taking the place of Mr. A. W. Jacobi, resigned.

The Department of Engineering of the University of Michigan, Ann Arbor, Mich., has issued an annual Announcement and Register of Alumni for 1896-7. The Register contains a list of Alumni, dating back to 1860.

The University of Nebraska, Lincoln, Neb., issues a brief Announcement of its School of Mechanic Arts, with photographic illustrations of the exterior and interior of its mechanical and electrical laboratory. Primarily the school is intended for those young men who expect to enter some one of the mechanical trades, although it is hoped that the stimulus given by this school will, in many cases, be such that a collegiate course in one of the engineering groups will be pursued. Tuition in the school is free, and other expenses are remarkably low. Prof. C. R. Richards is the director of the school.

Brown University, Providence, R. I.—The annual report of the President, together with the reports of professors in charge of the departments, have been published in a pamphlet of 80 pages. From the President's report we learn that increased expenditures for needed improvements and apparatus caused a financial deficit in the past year, to make up for which it has been necessary to reduce salaries and to discontinue the services of four professors in the departments of Germanic Languages and Literature, Biology, Philology, and Architecture. There are 35 students in the University pursuing courses in mechanical engineering and 38 in civil engineering. Mr. Edward C. Burnham, B. S., formerly instructor in mechanical drawing and engineering, has been made Associate Professor of Mechanical Engineering.

The Michigan State Agricultural College boasts of being the oldest agricultural college in the country, having been established in 1857, or five years before the passage of the Morrill Land Grant Act, by the U. S. Congress, which brought about the establishment of most of the agricultural colleges. The college is steadily increasing in prosperity and in influence. Five years ago a mechanical engineering department was established, which is under the direction of Prof. Chas. L. Weil, with Prof. P. M. Chamberlain as assistant in charge of shops. It is equipped with foundry, machine pattern and forge shops. The college receives a good income from the investment of the proceeds of its land grant; and an annual appropriation from the state.

From Rensselaer Polytechnic Institute we learn that Prof. James McGiffert, Jr., C. E., Assistant in Mathematics, has obtained leave of absence for one year in order to study pure mathematics at Harvard University, and to obtain the degree of Ph. D. His place has been filled by William E. Whitney, C. E. Benedict Papot, professor of French, has resigned, and Arthur de Pierpont has been appointed in his place.

At the New Hampshire College of Agriculture and the Mechanic Arts, Durham, N. H., recent new appointments to the faculty are: Joseph H. Hawes, instructor in free-hand drawing; George H. Furbish, foreman of woodwork; Clement S. Morris, actuary and purchasing agent.

At the Polytechnic Institute, Brooklyn, N. Y., the Institute course in civil engineering, the graduates from which have received the degree of B. S., has been extended by a year of post graduate work, and those completing the course will receive the degree of C. E. This work will be under the direction of Profs. Plympton and Kimball, assisted by Richard L. Russell, B. S., who, since his graduation, has been employed in the city Board of Public Works. The graduates of the civil engineering course have so far taken the positions in every civil service examination held in Brooklyn, over all competitors.

The Florida State Agricultural College, Lake City, Fla., is prospering under the management of its president, Oscar Clute, who was formerly president of the Michigan Agricultural College. The department of mechanics, while not having as complete an equipment as many of the Northern schools, is yet doing good and efficient work, both in theory and practice. During the vacation two of the graduates have set up without any outside help a complete electric plant, with a 100-HP. engine and two 1,000-light dynamos. Mr. N. H. Cox, one of the graduates of the school, has been elected assistant in mechanics. Prof. H. C. Powers is in charge of the mechanical department.

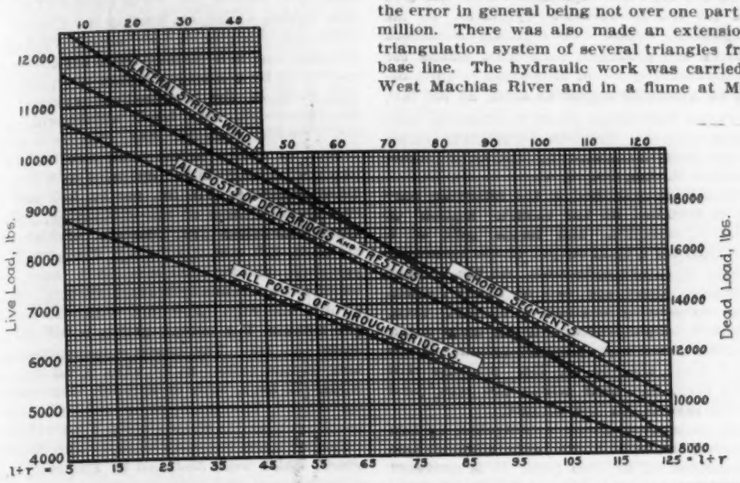
At the Michigan Mining School, Houghton, Mich., the following appointments have been made for the year 1896-7; Louis M. Hardenburgh, A. B., E. M., instructor in chemistry; Albert J. Houle, E. M., instructor in civil and mining engineering; Mr. George Wass, instructor in pattern shop; and Mr. Nathan S. Osborne, assistant in the physical laboratory. The school opens this fall with a large attendance. In September, 1895, the change from the rigid course to the elective system was made after much deliberation, and good results have followed. The entering class this year is larger than at any time since the organization of the school, ten years ago. The standard of work required has not been lowered, but the student is allowed freedom of choice to take the work best suited to his needs. An interesting paper on the "Elective System in Engineering Colleges," was read before the last meeting of the Society for the Promotion of Engineering Education, by M. E. Wadsworth, Ph. D., Director of the School, who perfected the system as used in the mining school.

At the Massachusetts Institute of Technology, the following is the provisional list of appointments for 1896-7: Associate Prof. C. Frank Allen has been appointed Professor of Railroad Engineering; Associate Prof. A. E. Burton, Professor of Topographical Engineering; Associate Prof. Dwight Porter, Professor of Hydraulic Engineering; Associate Prof. Peter Schwamb, Professor of Mechanism and Director of the Workshops; Assistant Prof. Linus Faunce, Associate Professor of Drawing; Mr. W. H. Lawrence, Assistant Professor of Architecture; Mr. A. G. Robbins, Assistant Professor of Highway Engineering; Dr. J. J. Skinner, Assistant Professor of Mathematics; Mr. G. H. Barton, Assistant Professor of Geology.

The school year opened on the 30th of September, and the preliminary registration shows a slight increase over the registration at the same period in 1895. Should the final registration bear the same relation to the preliminary this year as it did last year, the number of students will slightly exceed 1,200.

The increase in the number of students taking the course in Organic Chemistry has rendered imperative an increase in the floor space devoted to this laboratory. The necessary accommodations have been obtained by the removal of the chemical library from the fourth to the third floor of the Walker Building, and the conversion of this room into laboratories.

The Department of Architecture has recently secured an important addition to its collection of lantern slides. During the stay of the summer school, in London and Paris, Professer Homer selected 2,600 views of buildings and cities in Europe, Russia and the East. These views will supplement the present collection of the department, and will materially assist the illustration of the lectures given by its instructors. The views of Spanish, Russian, Indian and Chinese architecture are particularly valuable as they include a large amount of material at present not available in any other form.



UNIT STRESSES ALLOWED IN COMPRESSION MEMBERS OF MEDIUM STEEL BY COOPER'S 1896 SPECIFICATIONS FOR HIGHWAY BRIDGES.

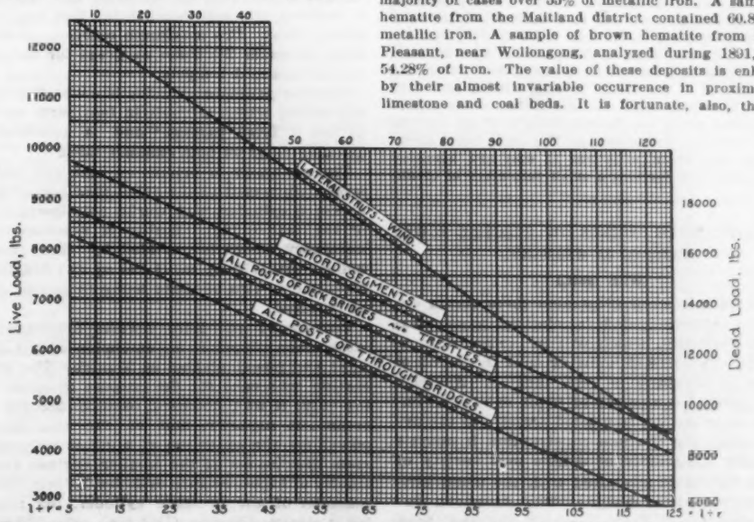
(l = length of member, in inches; r = least radius of gyration, in inches.)

The season of 1896-7 of the Society of Arts, opened on Oct. 8, with a meeting in the Rogers' Building. Prof. Sedgwick called attention to certain serious practical difficulties which beset the problem of supplying large communities with wholesome milk. The recent occurrence of numerous epidemics of typhoid fever in Massachusetts and elsewhere, which have been traced directly to infected milk, has led Prof. Sedgwick, who has personally investigated several of these epidemics, to propose a reconsideration of the whole question of milk supply of cities, with reference to the sources of danger and the means of removing them. At the same meeting a notable development of the biological work of the Institute on the technicological side was brought to the attention of the society. Mr. S. C. Prescott, Instructor in Biology, and Mr. Lyman Underwood, have, for some months, been closely engaged in a study of the causes of spoiling of canned clams and lobsters. This evil has become so common as to command the earnest attention of the trade. Not only is the outright loss considerable; but the offence given by the spoiled goods is of a kind seriously to affect the market. Messrs. Prescott and Underwood, in the course of their investigation, have found that under certain conditions imperfect sterilization occurs in the ordinary processes of canning clams and lobsters, resulting occasionally in the blackening and spoiling of the entire contents. They have identified certain micro-organisms in the spoiled cans, which are peculiarly resistant to the processes of sterilization, requiring the application of exceptional means to overcome the difficulty and to insure the safety of the foods in question.

The Institute's Summer School of Civil Engineering was held at Machias, Me., during the month of June. The members of the institute faculty in charge were Professors Alfred E. Burton, Dwight Porter and A. G. Robbins, and they were aided by Mr. H. K. Barrows, assistant in the department. Fourteen students of the third year made up the rest of the party. The work of the school is of an advanced nature, and only students who have finished the third year are admitted. The work was entirely in the field, and was in three parts, topographical, geodetic and hydraulic. In the geodetic work, a base line over half a mile in length was measured, with extreme accuracy, the error in general being not over one part in one million. There was also made an extension of a triangulation system of several triangles from the base line. The hydraulic work was carried on in West Machias River and in a flume at Machias, which conveys water to one of the sawmills of the town.

From the Teacher's College, New York, it is reported that the alliance with Columbia University, which has covered only certain work in the senior and graduate years, will hereafter apply to certain other under-graduate courses. The circular of the School of Engineering announces for 1896-7 a course of carpentry, joinery, wood-turning, pattern-making, molding and foundry work, to be held on two afternoons per week in the shops of Teachers' College under the instruction of members of Teachers' College staff.

At the University of New York, Mr. Collins P. Bliss, recently assistant engineer in the Globe Iron Works, of Cleveland, has been apointed instructor in the engineering school. Mr. Bliss is a graduate of Princeton in the class of 1888, and of the Columbia School of Mines in 1891. His special work is to be laboratory courses in steam engineering and practical hydraulics.



UNIT STRESSES ALLOWED IN COMPRESSION MEMBERS OF MEDIUM STEEL BY COOPER'S 1896 SPECIFICATIONS FOR RAILWAY BRIDGES.

(l = length of member, in inches; r = least radius of gyration, in inches.)

A GRAPHICAL METHOD OF FINDING ALLOWABLE STRESS IN COMPRESSION MEMBERS.

The accompanying diagrams show the unit stresses in compression members of both highway and railway bridges, allowed by Mr. Theodore Cooper's 1896 Specifications. The diagrams were plotted by Mr. A. Lincoln Hyde, Assoc. M. Am. Soc. C. E., New England Building, Cleveland, O., and we are indebted to his courtesy for the privilege of reproducing them here. The diagrams explain themselves, and will, we believe, be found exceedingly convenient by those engaged in the design of structural work.

IRON IN NEW SOUTH WALES.

In view of the opportunity offered to American capitalists and steel manufacturers to establish a steel plant and rail mill in New South Wales, as described in full in our issue of Aug. 27, it may be of interest to give some particulars of the iron deposits and iron works of the colony. In "The Wealth and Progress of New South Wales, 1894," which is the eighth issue of a work prepared by Mr. T. A. Coghlan, Government Statistician of the colony, and was only completed during the present year, we find some paragraphs relating to this matter, which we abstract as follows:

Iron is widely diffused throughout the colony of New South Wales, and occurs principally in the form of magnetite, brown hematite or goethite, limotite and bog-iron. Deposits of chrome iron are also found. Magnetite is the richest of all the ores of iron, sometimes containing a little over 72% of available metallic iron, though it is not often found reaching this very high percentage. These ores are widely distributed throughout the colony. The results of a number of analyses made from deposits at Brown's Creek, in the county of Bathurst, and at Wallerawang, where veins were opened out a few years ago, show that the samples of ore yielded from 40.80 to 56.85% of metallic iron. At Wallerawang, a variety of garnet, containing a large percentage of metal, occurs in conjunction with the ore in the veins, which is described as "extremely well adapted for reduction in the blast furnace." Brown hematite or goethite occurs in very extensive deposits in the Blue Mountain Ranges, the principal centers so far explored being situated at Mittagong, Picton, Berrima, Lithgow Valley, Wallerawang, in the Rylstone and Mudgee districts, and in the vicinity of Port Stephens. The result of a number of analyses of this kind of ore denotes that it is very rich in metallic iron, containing a percentage of 42.69 to 64.48%, and in the majority of cases over 55% of metallic iron. A sample of hematite from the Maitland district contained 60.83% of metallic iron. A sample of brown hematite from Mount Pleasant, near Wollongong, analyzed during 1891, gave 54.28% of iron. The value of these deposits is enhanced by their almost invariable occurrence in proximity to limestone and coal beds. It is fortunate, also, that the main lines of railway pass through the region where the deposits are most easily worked.

Limonite (a variety of brown hematite) principally occurs at Lithgow, Eskbank and Bowenfels, in the Blue Mountains; in several parts of the Hunter River coal field; and at Bulli, in the Illawarra District. This ore is usually found very rich in metal, and contains an average of over 50% of iron; while the English clay bands, which are mostly carbonates, only contain about 30% of metallic substance. It occurs in lenticular layers of no great extent, in the coal measures. Bog-iron ore, which is impure

limonite, is principally found at Mittagong, and assays of this ore gave a percentage of metal equal to an average of over 45%.

No other colony of Australia possesses deposits of iron ore approaching in extent or richness those of New South Wales; it is, therefore, probable that at some future time this colony will become the great seat of the iron industry of Australia. As illustrating the present extent of the supply required, the value of all descriptions of iron, machinery and iron manufactures imported into New South Wales in 1894 was $5,946,245. The average yearly import for the four years 1890-1893 amounts to $13,134,755 for New South Wales, and $32,507,230 for Australasia; and the quantity of pig-iron required to produce the material represented by these values is approximately 190,000 tons and 480,000 tons per annum for New South Wales and the whole group of colonies respectively.

In a report, dated January, 1891, by the late Mr. C. S. Wilkinson, Government Geologist, it is stated that the iron deposits in the districts of Mittagong, Wallerawang and Rylstone contained in sight 12,944,000 tons of ore, estimated to yield 5,853,000 tons of metallic iron. These districts are most favorably situated for the establishment of smelting works. Some years ago public attention in England was drawn to the possibility of manufacturing iron within the colony and a mining expert was sent out from that colony to inspect the iron, lime and coal deposits and to report upon the probable cost of establishing the industry in the colony; but so far the visit has been without result.

The principal works for the manufacture of iron from the ore are situated at Eskbanks, near Lithgow, where red siliceous ore, averaging 22%, and brown hematite, yielding 50% metallic iron, have been successfully treated. Abundance of coal and limestone are found in the neighborhood. The establishment, however, has for some time abandoned the manufacture of pig-iron for which it was originally built. The work now carried on consists of the re-rolling of old rails, and the manufacture of iron bars, rods and rails and of ordinary castings. The quantity manufactured from scrap during 1894 was 2,368 tons, valued at $85,850. A successful attempt has been made at Mittagong to make gas pipes, etc., from iron smelted from the ore, and taken direct to the mold, without first making it into pig-iron. Some years ago the iron smelting works at Fitzroy, Mittagong, were established, but after producing a considerable quantity of pig-iron the operations were discontinued. Some samples of ore, coal and limestone obtained in this district, with pig-iron and castings manufactured therefrom, were exhibited at the late mining exhibition at London, and obtained a first award. In the Broken Hill district, 254 tons of iron ore, valued at $1,280, were raised during 1894, chiefly for the purpose of flux.

Deposits of manganese ore have been discovered in various parts of New South Wales. Pyrolusite, in the form of black oxide and manganese, dioxide, occurs principally in the Bathurst districts and at Bendemeer. Wide veins have also been found in the Glen Innes district, near the Newton-Boyd road. Some of the specimens analyzed have yielded a very high percentage of metal; but the demand for manganese in the colony is very trifling, and until a foreign market is found, or local manufactories requiring the metal spring up, the rich deposits of this ore will remain comparatively untouched. The ore is found extensively in conjunction with iron in coal and limestone country, and often contains a small percentage of cobalt.

DIRECT CONNECTED ENGINES FOR ELECTRIC POWER STATIONS IN GERMANY.

(With inset.)

Our inset this week illustrates three steam engines, recently installed in electric power stations in Germany, which will be interesting to American engineers in showing that the trend of practice in Germany is like that in America, toward vertical compound or triple expansion engines of short stroke, connected directly to the dynamos, while the German construction is notable for greater complexity of details and variety of forms of valves as compared with the usual simplicity of American designs. The American engine-builder is usually compelled by the high price of skilled labor and by intense competition to build an engine which has the smallest possible number of parts, and to so design these parts that they can be made in quantities by machinery with a minimum expenditure of labor. The German builder seems to be subject to no such restrictions and is able to give freer scope to his ideas in designing. The result he obtains is apt to be, as shown in these illustrations, an engine which is admirable as a piece of workmanship, fairly durable and highly economical, but one which is not apt to be copied by American builders, on account of the restrictions to which they are subjected. Among the features especially noticeable in these German engines are massiveness of frames, large extent of bearing surfaces, and comparatively low speed, the highest piston speed figured from the data given below being 512 ft. per minute. In all three engines the expansion or cut-off valve of the high pressure cylinder is separated from the main valve, and is driven by a separate eccentric, and in the two larger engines separate expansion valves are also provided for the intermediate cylinders. In the triple-expansion engine two separate admission slide valves are provided, each with means for varying the travel by hand. This would be quite unusual in an American engine as small as 700 HP. The following description of these engines, from the "Zeitschrift des Vereines Deutscher Ingenieure," has been translated by Mr. O. J. Marstrand, Assoc. M. Am. Soc. C. E.

The first engine described in the following paragraphs is installed at the electric station of New-Bydzow, Bohemia, and forms part of a plant designed for a total output of 160 kilowatts, but capable of future extension. At the present time, however, there are two of these vertical compound condensing engines of 90 HP. each, with dynamos coupled directly to the main shaft. The diameter of the high pressure cylinder is 300 mm. (11.8 ins.); that of the low pressure 470 mm. (18.5 ins.), and their stroke 350 mm. (13.8 ins.) at 220 revolutions per minute.

The high pressure cylinder is controlled by two piston valves, the main valve being made in two parts, connected by an iron pipe. It is provided with double inlet passages, and fits closely, without any packing in the bushing, which latter is held in place by three set screws. Its weight is balanced in the usual manner, by increasing the diameter of the upper part. The expansion or cut-off valve, which is made in one piece, and weighs only 5 kilos. (11 lbs.) is also fitted into the main valve without any packing. The length of these valves is reduced as much as possible. The expansion valve is operated directly, while the main valve is operated by means of an intermediate rod, which may be readily removed. The hub of the fly-wheel forms the eccentric for working both valves. The weight of the expansion valve, rods and eccentric ring, and the reduced weight of the turning eccentric are balanced by a vertical plunger, moving in the top of the steam chest. The maximum reaction on the governor becomes 2½ times as great for unbalanced as for balanced weights.

The low pressure cylinder is controlled by only one valve, which is made in two parts as above. It has a Trick passage* and is provided with packing rings on both exhaust sides.

The air pump is driven by cast-iron rods and levers, connected to the cross-head pin of the low pressure cylinder, and works noiselessly in spite of the rather high number of revolutions. The necessary steam is provided by three fire-tube boilers with 110 sq. m. (1,184 sq. ft.) heating surface, one or two of these being in use at a time, as required.

The second and third engines illustrated have lately been placed in an extension of the electric light and power station at Munich. The original station was used for the purpose of street lighting only; it was, however, recently decided to increase its capacity, and to use the increased power for the operation of a street railway. The main dimensions of the smaller engines are: Diameter of high-pressure cylinder, 510 mm. (20 ins.); diameter of low pressure cylinder, 760 mm. (30 ins.); stroke, 480 mm. (18.9 ins.) with 150 revolutions per minute. They are vertical compound engines, having the dynamo coupled directly to the main shaft. The main valve of the high-pressure cylinder is a balanced slide valve, while the expansion valve is cylindrical; the low pressure cylinder has a balanced slide valve. The engines work at an initial pressure of 9 atmospheres (132 lbs. per sq. in.), and are condensing; they can, however at any time, be changed to exhaust into the atmosphere. The normal rating is 250 HP., maximum 350 HP. Under normal loading and a steam pressure of 9 atmospheres, a consumption of 7.25 kilos. (16 lbs.) steam per HP. hour with condensation, and 12 kilos. (26.5 lbs.) without condensation is guaranteed. The diameter of the fly-wheel is 2.8 m. (10 ft. 2 ins.) and it weighs about 6,900 kilos. (15,200 lbs.). The Hartung spring governor acting upon the expansion valve, controls the speed with a maximum variation of 1% for a change of load of 25%. The coefficient of fluctuation during a uniform loading is 1-250.

The third engine is also directly coupled to its dynamo, and is a vertical triple-expansion engine, controlled by a Hartung spring governor; the piston valve of the intermediate cylinder has a Meyer cut-off, with hand adjustment, and the low pressure cylinder has two balanced slide valves, as shown in the plan, also adjustable by hand. The engines are operated at a pressure of 12 atmospheres (176 lbs. per sq. in.), and can be run as condensing or non-condensing. Their principal dimensions are: Diameter of high-pressure cylinder, 490 mm. (19.3 ins.); diameter of mean-pressure cylinder, 800 mm. (31.5 ins.); diameter of low-pressure cylinder, 1,180 mm. (46.5 ins.); stroke, 600 mm. (23.6 in.), with 120 revolutions per minute. The normal rating is 500 HP., maximum 700 HP. The steam consumption per HP. hour is guaranteed at 6.5 kilos. (14.3 lbs.) and 10 kilos. (22 lbs.), with or without condensation, respectively. The diameter of the fly-wheel is 3.5 m. (11 ft.), and it weighs 8,600 kilos. (18,900 lbs.).

Special attention was paid in the Munich engines, which were designed by Engineer Hammel, to making all the principal parts easily accessible. Their massive construction will be particularly noticed, as also the fact of the bed plates being made in one piece, and of such a depth as not to require the stone foundation to rise above the floor level. The cross-head slides on the smaller engines are made plane surfaces to allow for the expansion of the two cylinders on a single base-plate. In the larger engines the three cylinders are independent of each other, and have cylindrical cross-head slides.

The injector condensers are placed below the engines; as are also the air pumps, of which there is one to each of the compound engines, and two for the triple expansion engines; they are operated by levers, extending from the cross-heads.

Three steam boilers provide the necessary steam; the heating surface of each boiler is 180 sq. m. (19,400 sq. ft.), its grate surface 3.7 sq. m. (40 sq. ft.).

The piping is all in duplicate; the diameter of the pipes at the boilers, and as long as they run separately, is 150 mm. (5.9 in.), while they join into pipes of 250 mm. (9.8 in.) diameter. Provision is made for expansion and contraction at the joints and elbows. The boilers are supplied with about 187,000 lbs. of water per hour. The feed pipes, and the steam pipes for the feed pumps, are built in a circuit, so as to make it possible to feed either boiler by either pump.

*A passage through the body of the valve which provides a double inlet for the steam, making what is commonly known as the Allen valve in America, and as the Trick valve in Europe.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

The Use of Sand on Track.

It is for the jury to say whether it was negligence not to have had sand on an electric car for stopping in emergencies, though it was a season when the rails were dry and dusty, where the evidence showed that the streets had been sprinkled shortly before the accident, and that the rails were slippery with thin mud; that in such cases the wheels of the car will slide, making it very difficult to stop; and that if there had been sand on the car it could have been stopped more easily than it was.—Penny v. Rochester Ry. Co. (Sup. Ct. App. Div.), 40 N. Y. Supp. Rep., 172.

Contributory Negligence of Passenger.

The Supreme Court of Minnesota holds that where a party falls and is injured by reason of getting off the car while it is slowing down for the purpose of stopping, he cannot recover, as he is guilty of contributory negligence.—Defoe v. St. Paul City Ry. Co., 68 Northwestern Reporter, 35.

Running a Dummy Engine Backward.

The running of a dummy engine, says the Supreme Court of Alabama, backward at a greater degree of speed than that prescribed by the city ordinance is a violation of same, though the speed was within the limitation for running forward, and it was safer to run backward than forward.—Highland Ave. & B. R. Co. v. Sampson, 20 Southern Reporter, 506.

Negligence of Sub-Contractor.

Where a street car company, authorized by charter to build a car line, lets a contract for construction to an independent contractor, without any agreement as to the particular manner in which the work shall be done, it is not liable for injuries caused by a wire stretched across the road by such contractor in the course of the work.—Sanford v. Pawtucket St. Ry. Co. (Sup. Ct. R. I.), 35 Atlantic Rep. 67.

Power of Railways to Adjust their Rates.

Subject to the two leading prohibitions, that their charges shall not be unjust or unreasonable, and that they shall not unjustly discriminate so as to give undue preference or disadvantage, the laws of the United States leaves common carriers, as they were at common law, free to make special contracts looking to the increase of their business, to classify their traffic, to adjust and apportion their rates so as to meet the necessities of commerce, and, generally, to manage their important interests upon the same principles as are regarded sound and adopted in other trades and pursuits.—Interstate Commerce Commission v. Ala. Midland Ry. Co. (U. S. Cir. Ct. App.), 74 Federal Reporter, 715.

Mining: Rule of Safe Place.

The United States Circuit Court of Appeals recently said: It is a positive duty which the owner of a mine owes to his employees, after the mine is opened and timbered, to use reasonable care and diligence to see that the timbers are properly set, and to keep them in proper condition and repair, and for this purpose to provide a competent mine boss or foreman, to make timely inspection of the timbers, walls, and roof of the mine. —Western Coal & Mining Co. v. Ingraham, 70 Fed. Rep., 219.

CIVIL SERVICE EXAMINATIONS for engineering positions will be held shortly in New York and Washington. On Thursday, Oct. 22, the New York City Civil Service Commission will hold an examination for Building Inspectors, who must be either "architects, civil engineers, masons, carpenters or iron workers who shall have served at least ten years as such." On Friday, Oct. 23, an examination will be held for Inspectors of Iron and Steel, who are required to have had ten years' experience. Applications for these examinations may be procured from S. William Briscoe, Secretary of the Civil Service Commission, New Criminal Court Building, New York city. On Oct. 28, 29, 30 and 31 the U. S. Civil Service Commission, Washington, D. C., will hold examinations for positions in the office of the Supervising Architect, Treasury Department, as follows: Senior architectural draftsman (6 years' experience required, salary $1,600 to $2,000 per year); architectural draftsman (4 years, $1,200 to $1,400); junior architectural draftsman (no experience, $800 to $1,000); structural iron draftsman (2 years, $1,600); heating and ventilating draftsman (2 years, $1,200); computer (no experience, $1,200 to $1,800). Applicants must file with their applications certificates or letters from present or former employers to show that they have had the required practical office experience with some reputable firm of architects or engineers.

THE EIGHT-HOUR LAW lately brought about an absurd suit in Providence, R. I., in connection with the government work on the new mortar battery at Fort Adams. The contractor for that work was sued by the Newport Trades Council for working men nine hours a day, and thus violating the United States Statute prohibiting government contractors from working their men more than eight hours per day. In the trial before U. S. Commissioner Blodgett, the charge was admitted in the case of the men named; but it was shown that it was an emergency case caused by springs breaking out in the foundation excavation. It was also pointed out that the statute provided that the law was not to apply in such cases, and the complaint was dismissed upon the ground that there was no proof of wilful intent to disregard the law, and because the time clause in the contract required extraordinary activity on the part of the contractor.

A METEOROGRAPHIC KITE was sent to an altitude of 9,385 ft. above sea level, at the Blue Hill Observatory on Oct. 8, thus breaking all previous kite altitude records. This "kite" was made up of seven Eddy and two Hargrave kites, from 6 to 9 ft. in diameter, exerting a pull of from 50 to 95 lbs. upon the piano-wire employed. More than three miles of wire were paid out. The kites carried a meteorograph making its record in ink. This record showed a temperature of 46° F. at the ground and 20° F. at an altitude of 8,750 ft. The kites remained at an altitude of over one mile for three hours.

THE PEARY ARCTIC EXPEDITION has returned to North Sydney, N. B., from its summer trip. The party was made up of representatives from Cornell University, the U. S. Coast Survey and the Massachusetts Institute of Technology. They bring back valuable botanical and other collections, and the U. S. Coast Survey party made a series of pendulum and magnetic observations. Lieut. Peary, who returns with the party, writes to the New York "Sun" that the result of the Nansen and Jackson expeditions proves that Greenland is the only land base for an expedition to the North Pole, and he outlines a proposed line of advance towards that point. He says that Lockwood and himself sighted the most northerly land known, extending certainly to 84° or 85° North. Lieut. Peary proposes to organize another Arctic expedition next season, associating with him the leading American geological and archaeological societies. In his absence the interior tableland of Greenland, traversed by him, has been named Peary's Land, by the American and European geographical societies.

A NEW ARMOR STEEL has been invented by Samuel Maxim, a brother of Hiram Maxim, of machine-gun fame. Mr. Maxim, according to the Philadelphia "Record," claims to have simplified the process of manufacturing the famed Wootz steel of India, still made by laborious crucible methods in that country. He submits specimens which are said to cut glass with ease and says he can, by his process, much increase the resistance of armor plate while greatly reducing the thickness and weight.

THE WALRAND-LEGENISEL STEEL PROCESS is meeting with considerable success in Europe, according to a paper read by Mr. George J. Snelus at the recent meeting of the Iron and Steel Institute of Great Britain. It has been adopted by two firms in France, two in Germany, two in St. Petersburg, Russia, one in Spain and one in Glasgow, Scotland, one in Erith, England (Fraser & Chalmers) and one in the United States (Potter & Hollis, Chicago). The size of the converters range from 350 kilos to 1 ton. The principal field for the process is for steel castings, which are made solid and very true to pattern, the melted metal being unusually fluid. It is also applicable to the manufacture of special steels which are required in smaller quantities than can be conveniently produced in the ordinary converter or in the open-hearth. A description of the process was given in our issue of March 19, 1896. It differs from the ordinary Bessemer process in the addition of ferro-silicon to the metal in the converter at approximately the time of flame-drop, and making an after-blow. The rapid combustion of the silicon raises the temperature most notably, and finishes the process by burning silicon to a solid (slag) instead of carbon to a gas.

THE SELECTION OF THE SAVAGE RIFLE by the New York state commission appointed to test guns presented by different manufacturers and to report which one was the best for the use of the state militia, has led to a protest by the Winchester Arms Co., of New Haven, Conn., one of the rivals of the Savage Gun Co. A hearing of the protest and of the reply was held by Governor Morton on Oct. 7, and his decision in the matter is reserved. Statements have been made in the daily papers that collusion between the Savage Gun Co. and some members of the commission was charged, but in the argument before the Governor by Gen. Tracy, representing the Winchester Arms Co., he expressly disclaimed any such charge, and claimed only that the commission was not composed of either trained army officers or gun experts, and that the commissioners were not competent judges of firearms.

A HEAVY EXPRESS ENGINE of the Columbia type has been built by the Baldwin Locomotive Works, of Philadelphia, Pa., for the "Black Diamond" express of the Lehigh Valley R. R., the engine having been designed by Mr. S. Higgins, Superintendent of Motive Power of that road. The engine has four driving wheels (the rear pair being the main drivers), a four-wheel leading truck and a pair of trailing wheels. It has the Wootten firebox, cast-steel driving wheel centers, steel engine and tender wheels, rods of I-section, metallic packing, and all the latest improvements in boiler fittings, etc. The boiler jacket is of steel, painted black. The general dimensions are as follows:

Driving wheels (4)	6 ft. 4 ins.
Truck wheels (4)	3 " 6 "
Trailing wheels (2)	4 " 6 "
Tender wheels (8)	3 " 0 "
Driving axle journals	8½ × 11 ins.
Wheelbase, driving	13 ft. 0 ins.
Wheelbase, total	24 " 0 "
Weight on driving wheels	81,800 lbs.
" on truck	29,100 "
" on trailing wheels	30,050 "
" total of engine	140,950 "
" tender	85,000 "
Cylinders	19 × 26 ins.
Steam ports	1¾ × 19 "
Exhaust ports	3¼ × 19 "
Valves (Richardson balanced), travel	6¼ "
Boiler, diameter of barrel (outside)	5 ft. 1 in.
Boiler pressure	180 lbs.
Tubes (steel), 265, diameter	2 ins.
" length	15 ft. 0 "
Firebox (radial stay), length	9 " 6 "
" width	6 " 8 "
" depth, front and back	3 ft. 10¼ "
Grate area	63.97 sq. ft.
Heating surface, tubes	2,081.24 " "
" " firebox	148.98 " "
" " total	2,230.22 " "
Smokestack (taper), height of top from rail	14 ft. 10 ins.
Capacity of tender tank	4,000 gallons.
Brake fittings	Westinghouse driving-wheel brake.

THE SIBERIAN RAILWAY may be built across Northern Manchuria, according to a Pekin cable despatch, which states that the Chinese government has granted right of way under the condition that China can purchase this line 30 years after completion. The same despatch says that permission to build a branch line across Southern Manchuria was refused by the Chinese. The original location of the Trans-Siberian railway departed from the present line at Lake Baikal and cut across Northern Manchuria, directly to Vladivostock, instead of following the more northerly and crooked Amoor River. The saving in distance by the southern line would be about 500 miles between Lake Baikal and Vladivostock. This is apparently the right of way referred to as granted. What Russia wants, and will doubtless somehow obtain in the near future, is a branch from this line, at about Petung, south to the Gulf of Pechili, and to a port open at all seasons. The distance from Petung to Port Arthur is only about 500 miles, or about 150 miles more than from that point to Vladivostock. This is doubtless the branch through Southern Manchuria which the Chinese refuse, for the present.

THE TENNESSEE CENTENNIAL EXHIBITION, which is to be held in Nashville from May 1 to Nov. 1, 1897, has opened an Eastern headquarters at No. 229 Broadway, New York, under the direction of Mr. Algar M. Wheeler, Commissioner for the Eastern States, where intending exhibitors may obtain all necessary information. A handsome illustrated circular has been printed by the management, giving views and descriptions of the buildings, and the "Centennial News Bulletin," a finely printed four-page sheet, is issued regularly from Nashville by Mr. Leland Rankin, chief of the Bureau of Promotion and Publicity. The illustrations in the "News" of Sept. 10 show the condition at that date of a number of the principal buildings. From the appearances of the photographs we should judge it likely that the promise made by the management to the effect that all the buildings will be completed three months before the opening day will be kept. The exterior of some of the buildings is practically completed already. The most remarkable building of the exhibition will be the Fine Arts Building, which is a reproduction of the Parthenon in Athens. It will occupy the "Acropolis" of the exhibition, and the other buildings will be grouped around it.

THE NEW MOGUL FREIGHT LOCOMOTIVES built by the Schenectady Locomotive Works, Schenectady, N. Y., for the New York, New Haven & Hartford R. R., are particularly noticeable for the great length of cylinder stroke (28 ins.) and the great boiler capacity, the huge wagon-top end extending nearly to the smokebox. The general dimensions are as follows:

Driving wheels	5 ft. 3 ins.
Truck wheels	2 " 9 "
Driving axle journals	9 × 12 ins.
Driving wheel base	15 ft. 2 ins.
Total wheel base	23 " 3 "
Weight on drivers	124,400 lbs.
Weight, total	144,200 "
Cylinders	20 × 28 ins.
Steam ports	1⅞ × 20 "
Exhaust ports	3 × 20 "
Boiler, diameter of first ring	5 ft. 2⅛ "
Boiler pressure	190 lbs.
Firebox, length	9 ft. 0¼ in.
" width	3 " 4⅛ "
Grate area	39.22 sq. ft.
Tubes; number, 312; diameter	2 ins.
" length	12 ft. 0 "
Heating surface, tubes	1,946.72 sq. ft.
" " firebox	164.38 " "
" " total	2,111.10 " "
Capacity of tender tank	4,500 gallons.
Capacity of coal space	20,000 lbs.

AN ELECTRICAL OSCILLATOR has just been patented by Nikola Tesla for transforming either direct or alternating currents into electrical vibrations of very high frequency. A number of inventors have been at work along this line chiefly because a high frequency current is believed to be the main requirement necessary to make vacuum tubes of practical use in electric lighting. There are also other uses to which a successful high frequency machine can be put, such as the production of ozone and of Roentgen phenomena, and all purposes for which a Ruhmkorff coil is now employed. The "Electrical Review" publishes an interview with Mr. Tesla in which he states that the invention is for use with ordinary electric lighting circuits and that the machine is simple in construction and can be manufactured at small cost.

A NEW CLASSIFICATION OF THE EARTH'S SURface has been devised by Prof. Hermann Wagner, of Gottingen, one of the most prominent of the geographers of Germany. He divides the total area of the surface of the globe, above and below sea level, into five regions, which may be tabulated as follows, using sea level as the datum:

Regions.	From.	To.	Mean elevation or depression, ft.	Percentage of total area.
Culminating, above	+ 3280	.....	+ 7,200	6.
Continental plateau	+ 3280	— 656	+ 800	28.3
Continental slope	— 656	— 7544	— 4300	9.
Oceanic plateau	— 7544	— 16.400	— 13.500	57.3
Depressed area, below.	.....	— 16.400	— 20.000	3.

He places the mean elevation of the earth's crust at a depth of 7,500 ft. below the actual sea level; and he figures that of the total area land occupies 28.3% and the sea 71.7%; or a ratio of 1 land to 2.54 water.

STEEL PORTABLE VOTING BOOTHS have been used in New York city for the last three years. They are owned by the Buffalo Steel House Co. and rented for $90 per annum; the company has to move and store the houses, keep them clean and to do all the heating and lighting. These booths measure 12×28 ft., weigh about 3,000 lbs. each, and have six voting compartments with all the necessary room for transacting business. They replace the old wooden booths and have given general satisfaction.

A SAMPLE WAREHOUSE, for exhibiting American products of various kinds, is to be opened at Caracas, Venezuela, under the auspices of the National Association of Manufacturers of the United States. The concession obtained from the Venezuelan government permits the entry of goods for exhibit free of duty, with the dues to be paid only in case of actual sale. The Association, with its headquarters at 1751 North Fourth St., Philadelphia, issues a circular of information describing the building proposed for the permanent exhibition, with a plan of the spaces allotted for goods; and this circular also briefly sets forth the population, area and products of Venezuela, and the possibilities of trade with that country.

THE SMOKE NUISANCE is now being attacked by the cities of Buffalo and Kansas City. In Buffalo the aldermen passed an ordinance which the mayor has vetoed on the ground that it is not effective for the purpose for which it is framed, and that it will put undue burdens upon manufacturers. He recommends that a new ordinance be framed which will better meet the requirements of the situation. In Kansas City the matter is being taken hold of by a "Smoke Abatement Association," which has framed an ordinance for consideration by the city council. It is modeled after the one now in operation in St. Louis, which has proved to be very efficacious in diminishing the smoke from large chimneys.

THE PRODUCTION OF COAL IN OHIO in the year 1895, according to the annual report of Hon. R. M. Haseltine, Inspector of Mines, showed a substantial increase over that of 1894. The report gives the year's production as 13,683,879 tons, an increase over the preceding year of 1,773,600 tons. The increase in lump coal is 1,349,231 tons; in nut coal 113,755, and in pea and slack 310,674 tons. The unusual percentage of gain in lump coal is ascribed to the increased use of mining machines and the adoption of improved methods in mining. Of the year's production, 3,120,456 tons were mined by machinery, an increase of 564,990 tons as compared with 1894.

The average time worked is given at 156 days as against 132 days during the preceding year. Four hundred and forty-seven hands were employed in operating the machines and 3,374 hands in blasting down and loading the coal after it has been undermined by the machines.

There are 1,187 mines in the State—424 employ ten men and upward and 763 employ a less number. Of the entire number of mines, 1,097 were in operation during the year. The number of persons that found employment in and about the mines during the year was 22,416 miners and 6,582 day hands, as against 25,163 miners and 6,330 day hands during 1894. Deducting from the whole number of miners employed those who were engaged in operating mining machines, there were 18,645 miners employed as pick miners, a decrease of 3,863 as compared with 1894.

BOOK REVIEWS.

A TEXT BOOK ON SHADES AND SHADOWS AND PERSPECTIVE.—Prepared for the use of Students in Technical Schools. By John E. Hill, M. S., M. C. E., Associate Professor of Civil Engineering, Brown University. Second edition, revised and enlarged. New York, John Wiley & Sons; London, Chapman & Hall, Ltd. 1896. 8vo; cloth; pp. 101, with 12 folding plates. $2.

This text book is designed to furnish a short course in shades and shadows, and one-plane perspective, for students who have studied the elements of descriptive geometry. Prominence is given to the fact that the subjects treated are branches or applications of descriptive geometry, and follow that subject in logical sequence. For this second edition the book has been thoroughly revised and in the main re-written. We believe it will be found a very satisfactory text book for technical schools. The author's style of treatment is very clear and concise, and the 52 illustrations in the folding plates are well executed.

WEALTH AND PROGRESS OF NEW SOUTH WALES, 1894.—By T. A. Coghlan, Government Statistician. Eighth Issue. Sydney, N. S. W., Charles Potter, Government Printer. 8vo.; 1,021 pp.

This document briefly sketches the history, physical geography, geology, fauna and flora, and the political, financial and commercial growth of New South Wales. The list of contents also covers mineral, agricultural, industrial and educational statistics, together with much other matter relating to progress of this section of the world. The period covered by the tables is limited to ten years; but the reader is referred to the "Statistical Register" for more detailed figures.

MATHEMATICAL TABLES.—Consisting of Logarithms of Numbers, 1 to 10,800, trigometrical, nautical and other tables. Edited by James Pryde, F. E. I. S. New Edition. New York, D. van Nostrand Co. 8vo.; 454 pp. $1.75.

This edition is greatly enlarged and the tables of logarithms of numbers, logarithmic sines, tangents and secants, and those of natural sines, cosines, versed sines and chords, tangents and cotangents, secants and cosecants, and of circular arcs, have been carried to seven decimal places and rearranged so as to be more convenient for use. The greatest care has been observed in making these tables accurate, and to secure this end they have been collated with six of the best sets of tables known. The price remains the same as for the old edition.

A DICTIONARY OF GEOGRAPHIC POSITIONS.—Bulletin No. 123, U. S. Geological Survey. By Henry Gannett, Chief Topographer, Washington, D. C., Department of the Interior, U. S. Geological Survey. 8vo.; 183 pp. $0.15.

This will be found an exceedingly useful book of reference to many engineers and land surveyors. For some years past the Division of Topography in the U. S. Geological Survey has been engaged in compiling positions determined within the United States which are believed to be sufficiently accurate for use in preparing its maps. It is placed before the public at the very modest price stated, and the list covers nearly 10,000 positions, with the latitude and longitude expressed to hundredths of a second, together with the authority. These positions are arranged by states, and within states by "square degrees," or the quadrilateral limited by consecutive parallels and meridians. But an alphabetical index covering all the positions noted enables any one to readily find those marked. A short sketch of the several authorities used in the compilating of the list is given. A dictionary of altitudes has also been compiled by Mr. Gannett, and is issued as Bulletin No. 76, and sold for 25 cents by the Geological Survey.

DES INGENIEURS TASCHENBUCH.—Herausgegeben vom Akademischen Verein "Huette." 16th edition. Berlin, 1896. Wilhelm Ernst & Sohn. 2 vols., 7×4½ ins.; pp. 984 and 618. Price in Germany, bound in leather, 16 marks = $4.

The standard German engineers' "pocket-book" has now grown too large for one pocket, and it has been divided into two volumes. "Huette" differs from the American engineers' pocket-books, not only in being larger, but in its methods of treatment. It devotes considerable space to descriptions of apparatus, the chapter on steam boilers, for instance, covering 103 pages, and including cuts of all the principal styles used in Germany. It is less elementary than the American books, assuming a considerable amount of mathematical knowledge on the part of the user. The subject of mechanics begins with velocity and acceleration, instead of with force, and equations involving a knowledge of the differential calculus are employed in its discussion. The second volume is chiefly devoted to engineering practice in the departments of railways, buildings, bridges, steam vessels, furnaces, flour mills, paper making, etc. The work is an invaluable reference book to any engineer who has an acquaintance with the German language.

UNIVERSAL DIRECTORY OF RAILWAY OFFICIALS, 1896.—Compiled from Official Sources by S. Richardson Blundstone, Editor of the "Railway Engineer." Directory Publishing Co., 8 Catharine St., Strand, London, England. Cloth; 8vo.; pp. 375; 10 shillings ($2.50).

This is the second edition of the directory which was reviewed in our issue of Nov. 28, 1895, and it is stated that about 150 railways and 32 pages of matter have been added in this edition. Some of the omissions and inaccuracies noted in the review of the former edition reappear now, Colombia being credited only with the Girardot Ry., and no mention being made of the newer and more important lines. Even the Panama Railway is again omitted. One of the weak points in this, as in the first edition, is the treatment of the railways of the United States, and it is difficult to understand what system of selection has been employed, several small lines being included, to the exclusion of some of the great trunk lines. It also mixes up the Knoxville & Ohio (65 miles) with the Southern Ry. (4,649 miles), by which it is leased, and gives the former little line a long list of officers of the latter line. These defects are doubtless due to a lack of knowledge of the railway systems of this country, but they greatly detract from the usefulness of the work, in fact the directory of American railway officers would be of little use in this country, where several much cheaper and far more complete and accurate directories are regularly issued. The information respecting the railways of Great Britain, the British colonies and European countries is naturally pretty complete, and in the whole the book is probably as complete and accurate as could be expected, with the exception of the United States section, the omissions in which are glaring and inexcusable. The volume is well and clearly printed on a good quality of paper (though the arrangement and type are somewhat confused in style), and it is strongly and compactly bound.

IRON MAKING IN ALABAMA.—By William B. Phillips, Ph. D. Published by the Alabama Geological Survey, Eugene Allen Smith, Ph. D., Director, Montgomery, Ala. 1896. Pamph.; 8vo.; pp. 164.

The development of iron making in Alabama in the ten years from 1880 to 1890 was one of the most remarkable events in the history of the iron trade. Not less remarkable has been the progress of the last three years in cheapening the cost of production to such a point that it has been possible when freight rates were favorable to ship a portion, although a small one, of the product of the state to England and other foreign countries to compete with English iron. The pamphlet before us was written by Dr. Phillips for distribution by the Geological Survey, and it gives a very complete account of the present status of the industry chiefly from the standpoint of the miner of the raw materials used in iron making. The growth of the manufacture of coke pig iron in the state is well shown in the following figures: Tons of 2,240 lbs.—1876, 1,262 tons; 1880, 35,232 tons; 1885, 133,808 tons; 1890, 718,383 tons; 1892, 835,840 tons; 1894, 556,314 tons; 1895, 835,851 tons. The production is now about 10% of the total iron production of the United States. The pamphlet is largely devoted to a description of the ores, fuels and fluxes found in the state, then follows a directory of the furnaces, rolling mills, etc., with a brief description of each, and a number of short papers by different writers on the grading of Southern pig iron, the market for Alabama pig, etc. The papers on the grading of pig iron should be read by all who are interested in the purchase or use of pig irons for foundry purposes. Dr. Phillips shows clearly the troubles which arise from the present method of having eleven different grades for Southern pig irons, and recommends that they be reduced to six, having chemical analyses as follows:

	Silicon.	Combined Carbon.	Sulphur.
Silvery irons.. ..	5 to 6	0.10 to 0.30	0.01 to 0.04
Soft irons..	3 to 5	0.20 to 0.60	0.01 to 0.05
Foundry irons ..	2 to 3	0.30 to 0.90	0.01 to 0.07
Gray forge..	1 to 2	0.40 to 1.25	0.04 to 0.09
Mottled..	0.6 to 1	0.50 to 1.80	0.06 to 0.11
White..	0.1 to 0.6	1.00 to 2.50	0.08 to 0.30

He strongly favors, of course, the grading of irons by analysis and condemns the old method of grading by fracture.

METALLIC STRUCTURES, CORROSION AND FOULING AND THEIR PREVENTION.—A Practical Aid-Book to the Safety of Works in Iron and Steel, and of Ships; and to the Selection of Paints for Them. By John Newman, Assoc. M. Inst. C. E. London, E. & F. N. Spon; New York, Spon & Chamberlain. 12mo.; pp. 374. $3.50.

The author appears to be a professional book-maker rather than an engineer. The title page gives the names of five other books which he has written, one of which has a rather taking title, "Scamping Tricks and Odd Knowledge Occasionally Practised upon Public Works;" the others being on earthwork slips, concrete, cylinder bridge piers, and foundations. What special qualification the author has for writing a book on the subject of corrosion is not apparent, except in the following note from the preface.

The author, having had his attention specially directed during many years, to the subject of corrosion and fouling and their prevention, has placed his experiences on record, and that of others in all parts of the world, to whom he offers his acknowledgments, and also to the editors of the various technical journals mentioned.

From an examination of the book itself it would appear that the author's method of book-making is to have a box or drawer into which for several years he puts clippings or notes of the subject upon which it is his intention to write, and then in due time to arrange the matter into shape for publication in the best way that he can, with the least labor possible in studying the subject or in arranging the matter in logical and literary form. There is a "long-felt want" for a good book on the subject of corrosion; the author has recognized the want, and attempts to fill it with a "pot-boiler." Of course the book contains a great quantity of useful information, clipped from various sources, but the useful matter is so hidden amongst a mass of imperfectly digested, if not useless, stuff that a great effort is required to find it. For instance, in searching to find what is the author's opinion on the subject of the relative corrosibility of different grades of wrought iron, on page 31, we find:

The greater the purity, homogeneousness and freedom from foreign matters of the metal, other conditions being similar and in accordance with specified requirements relating to strength, the less will be the corrosion.

On p. 34 we find what appears to be a contradiction of the above:

Hard and crystalline irons are generally considered to be less oxidable than ductile or fibrous irons.

The following sentences, also from p. 34, are examples of the characteristic style of the author:

In steel, uniformity can be approached more than in iron; however, the cinder in iron and the scale of steel are different. The former is a dielectric glassy substance and has no corrosive influence, while the scale produced in rolling steel has a very deteriorating effect, as it is a magnetic oxide negative to the steel, and therefore corrosion is rapid, as also if such scale is rolled into steel plates. Professor Kick, of Prague, after many experiments, which he only regards as indicating the probable general rule, not as proving it, with nitric, sulphuric and hydrochloric acids and their cerubinations, with mordants composed of the salts of copper, etc., found that soft and fibrous iron of good quality, also fine grained iron, when attacked by the acid, is uniformly so, and with a limited elimination of the carbon, the surface retaining a dull lustre, a few incised specks and cinder-like holes being only observable. Coarse-grained iron and hot-short iron were found to be more powerfully attacked.

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